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EVALUATION OF THE BRIDGE WEIGH - IN - MOTION SYSTEM

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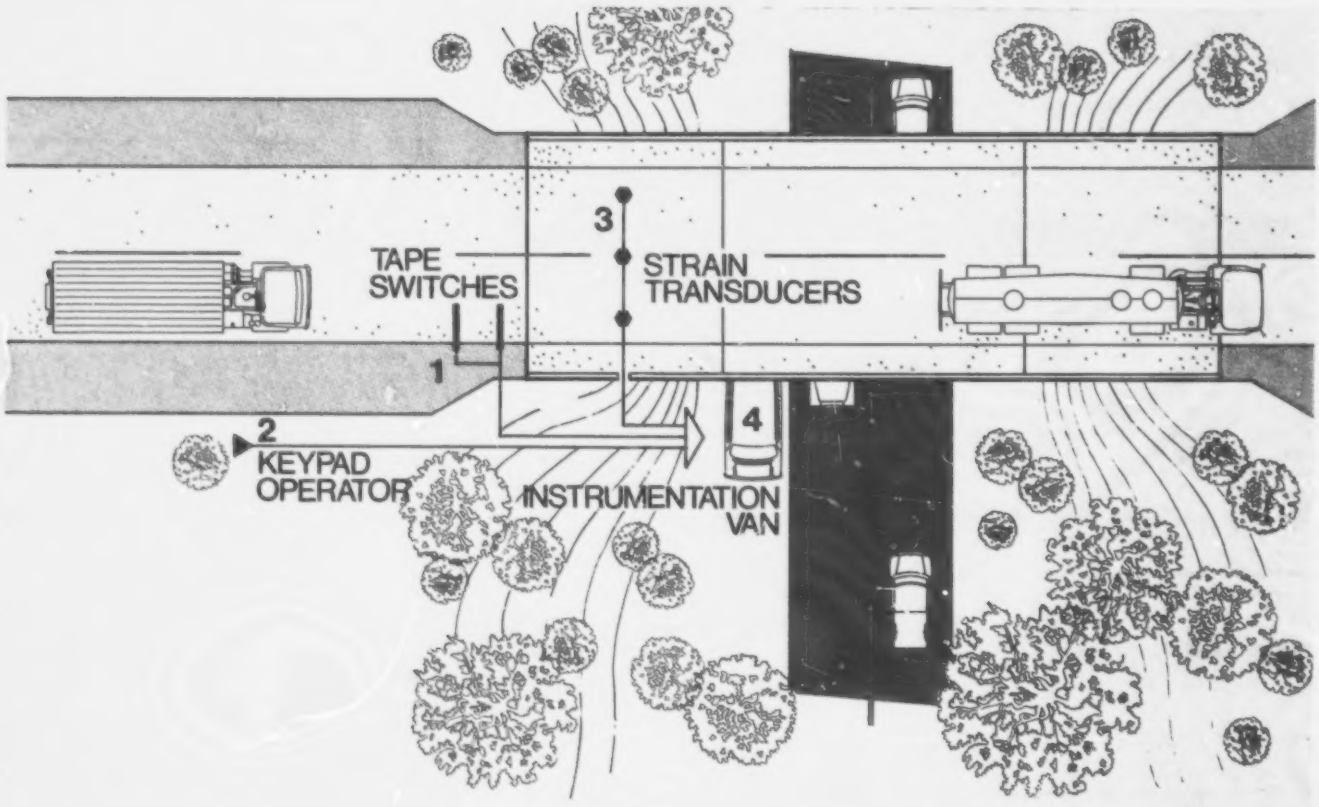

WISCONSIN DEPARTMENT OF TRANSPORTATION
DIVISION OF PLANNING AND BUDGET
MARCH, 1985

EVALUATION OF THE BRIDGE WEIGH-IN-MOTION SYSTEM

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FOREWORD

For the past two years the Wisconsin Department of Transportation (WISDOT) has participated in FHWA's "Demonstration of Coordinated Weight Monitoring and Enforcement Program Using Weigh-In-Motion (WIM) Equipment" as part of the Rural Technical Assistance Program. WISDOT has acknowledged the potential benefits of utilizing WIM technology to improve as well as increase the positive elements associated with its vehicle weighing programs.

Primary factors such as portability, unobtrusiveness and the overall benefit/cost ratio led to WISDOT's selection of a Bridge Weigh-In-Motion system to conduct Truck Weight Study data collection activities. The demonstration project has subsequently allowed our department to test the operational performance of the Bridge WIM system while also A) establishing a comprehensive and representative base of truck weight data, B) testing new approaches to motor carrier enforcement, and C) promoting coordination between the various weighing programs. WISDOT is firmly committed to providing substantial support to ensure these activities continue throughout the future.

During this time span the project has focused on three major activities. The first activity involved conducting a newly created Truck Weight Study (TWS). Recommendations were made to change several elements of the original TWS program including the incorporation of the Bridge WIM for data collection. This type of WIM equipment in particular was required to expand geographic, functional road type, seasonal, and temporal coverage of survey operations. While many adjustments were necessary to conduct such a survey, the program was essential for developing useful data for application in motor carrier enforcement, pavement design and pavement management, and highway cost allocation studies.

The second major activity consisted of evaluating the operational performance of the Bridge WIM. Several independent tests and analyses were conducted to determine the accuracy of data outputs and equipment performance under various conditions. Costs of operation as well as comparing the WIM data to that obtained through previous methods of weighing vehicles has been examined. Other factors associated with the equipment which have been addressed include ease of operation, portability, reliability and utilizaiton as an enforcement screening device. All of these evaluation efforts assist in determining the limits and utility of the Bridge WIM system.

The third major activity involved more closely coordinating the Truck Weight Study and Motor Carrier Enforcement personnel through selected phases of work. Because of the present lack of timely and adequate truck traffic data, scheduling and placement of MCE personnel is done instinctively on the basis of perceived or anticipated patterns of overweight trucks. As part of our analysis the Bridge WIM was used near permanent scale facilities with no enforcement present to determine what types of trucking patterns exist under such circumstances. In addition, the Bridge WIM was used at pre-determined sites which are well known for having seasonal overload carriers. The results of this planning effort provide many observations concerning the overweight trucking question.

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The Bridge WIM system itself uses highway bridges as equivalent static scales which in turn provide an automated solution to truck weight surveys while allowing unbiased evaluations of the normal traffic stream. Vehicles are neither slowed nor diverted, and drivers are unaware of the weight measurement operation in progress for the most part. Since all equipment is stored and transported in a mobile instrumentation van, no special platforms, scales, off-road ramps, or booths are necessary.

The system consists of the following four major components. Also please refer to the installation diagram on the cover of this report.

1. Tape switch axle detectors, to initiate the system and determine vehicle velocity, are fastened to the roadway surface.

2. A key pad to record the categorical truck body types and other visible hauling information by an observer.

3. Specially designed and reusable strain transducers, which measure bridge structural response for vehicle weight determination, are attached to the girders.

4. A minicomputer and compatible electronic apparatus which receives, analyzes and stores the data (individual truck gross and axle weights, spacings, speeds, class) in a mobile instrumentation van, usually parked under a bridge.

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INTRODUCTION

The Wisconsin Department of Transportation (WISDOT) has recently completed its participation in FHWA's Rural Technical Assistance Program demonstration of WIM technology. WISDOT's Division of Planning and Budget has directed the project from its inception while the Division of State Patrol, responsible for motor carrier enforcement, has played a key role in several operational aspects associated with the WIM system. The demonstration project has allowed WISDOT to test the overall performance of the Bridge WIM (BWIM) equipment as well as develop an entirely new comprehensive and representative truck weight data base.

TRUCK WEIGHT STUDY BACKGROUND

In the past, truck weight data was collected as a means of determining pavement loadings which in turn could be used in highway design requirements and estimates of pavement life. The Division's Traffic Data Unit collected planning information at 14 permanent and 3 portable weighing stations located on the rural interstate and state trunk highway systems. Certain situations required portable scales to be used in conjunction with permanent roadside locations to determine vehicle weights and related data in the opposite lane of traffic. In all, data was collected for a time period of 16 to 24 hours on a summer weekday at each station. Because of the importance and constantly changing nature of this data and information, a survey of truck weights, vehicle classifications and origin/destination details among other items was required for submittal to FHWA every two years. From this survey the FHWA was able to develop a basis from which it could determine truck weight trends and revise estimates of equivalent axle loadings for various truck classifications. Much of this factual material was then used in design and maintenance computations.

During the previous two years the Division's Traffic Data Unit collected truck weight data using the BWIM system at 19 bi-directional sampling stations. These stations were located on several distinct highway jurisdictions and functional road classes such as rural and urban interstates and state trunks, as well as principal and minor arterials. Survey operations at seven of the stations were expanded to include nights, weekends and the four separate seasons of the year. Knowledge of temporal and seasonal variations in truck travel allows for the development of more accurate estimates of average annual loads which is valuable for users such as motor carrier enforcement. The overall consensus is that the increase in stations has vastly improved statewide coverage of the Truck Weight Study and as a result a more representative and valid sample of trucking information is available which provides significant data on a number of highway corridors.

Truck Weight Study Sampling Plan

The sampling plan developed in Wisconsin provides procedures used by WISDOT for determining the number and locations of sampling stations for its Truck Weight Study. The program's purpose is to collect representative trucking characteristic data for use in pavement design, highway cost allocation, motor carrier enforcement and other planning and research activities. Previous weight studies produced data of limited value due to inadequate road type and geographic coverage. In addition, stations were selected without any

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statistical guidelines for sampling. Utilizing new weighing-in-motion technologies and emphasizing the collection of basic weight data permits a more random selection of weigh stations and a more comprehensive sample of truck traffic. The sampling plan developed relies heavily upon user needs and statistical criteria to help ensure a valid and meaningful sample.

Using data from a recent Highway Performance Monitoring System Wisconsin Truck Weight Case Study, the number of required stations was calculated on the basis of the average variability of truck weights in the State. These stations were distributed across recommended road types in proportion to the size of the total population of truck vehicle miles of travel on each road type. Stations by road type were then assigned to counties using a weighted random numbers procedure while criteria was presented for selecting corridors and sites where stations should be established. This kind of sampling approach generates more representative and comprehensive data that better describes general as well as specific chracteristics of the overall truck population throughout the State.

Previous Considerations

Obtaining accurate information on truck weight presents a problem no matter what type of system is chosen to conduct the survey. One of the main problems of prior years is the fact that costs of collecting truck weight data were high which limited the amount of data that could be collected. Until the advent of the BWIM system several other factors which follow have contributed to or caused inaccuracies in the data that was collected.

> Overweight vehicles avoided weigh scales which skewed the information by creating a lack of representative data on heavy trucks and in turn diminished the quality of the data collected;
>
> Costs of the manpower necessary to operate a station as well as the overall costs of purchasing and maintaining scales made it prohibitive to expand vehicle weighing programs;
>
> Small numbers of locations where weigh stations exist statewide did not represent either a random or a representative sample of traffic on the state highway system;
>
> Considerations necessary for weigh station crew safety as well as safety of the travelling public, turnaround space and scale accuracy limited the number of sites suitable for the existing portable scales.

The enforcement of weight laws causes overweight trucks to take evasive action such as using bypass routes to avoid any operating weigh station or waiting at a truck stop until the scale facility closes. The result of this avoidance is weight data which underreports the heaviest trucks and consequently causes average survey weight to fall below the actual average weight.

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With the use of the Bridge WIM system, many of these drawbacks could potentially be eliminated. The basic concept of the BWIM scale is that it has the capability to unobtrusively weigh vehicles without forcing them to stop. Weigh-In-Motion is not only an entirely new and innovative means of collecting representative and qualified TWS data but it can also increase the efficiency of existing scale houses while obtaining "missing" data not previously available through the use of static scales. There is, however, one major obstacle which stands in the way of this system becoming the most appealing or predominant weigh-in-motion device in the country. That obstacle, which is discussed in great detail throughout the remainder of this study, deals with the differences found between weights measured with the BWIM equipment and those measured with fixed scales.

DYNAMIC WEIGHT VERSUS STATIC WEIGHT

The major concern which has continued to impede full utilization of the BWIM equipment from the outset centers around the question of "dynamic weight" versus "static weight". As our tests and analysis has proven, the measured weight of an axle on a moving vehicle (dynamic weight) often differs from the measured axle weight of a stationary vehicle (static weight). Previous research has demonstrated that this difference is due to the fact that the load and suspension of a moving vehicle interact with pavement conditions and contours of the roadway in such a way that the size of the load experienced by each wheel of the truck bounces. This vibration or oscillation of the vehicle's forces upon the highway causes the load experienced by the tires to either decrease as the truck bounces upward or increase as the truck lands on the pavement. Our research and analysis has also lended support to the contention that the faster a vehicle is travelling and the rougher the road surface, the greater the range of oscillation of the dynamic weight around the static weight. Since BWIM dynamic weights are calibrated to a known static weight, weight differences encountered using the BWIM have been substantial, with often a variance upwards of ±15% per individual axle at a given site.

As a result of the potential weight errors which exist on any given truck, some specific enforcement operations requiring high levels of accuracy which were anticipated could not be conducted. One of these activities was the implementation of a selective enforcement plan within a target area in southeastern Dane County. By using the Bridge WIM at numerous (10) sites for extended periods of time the overload truck problem could be defined by road system, hour of day, day of week and season of the year. The majority of the enforcement activities which were conducted utilized a sorting methodology from a data base developed at each individual enforcement location. The sorting system limits the analysis to those vehicles which are potentially overweight by estimating the range of error for each individual truck sample. When implemented this process allows static scale use to be limited to those vehicles likely to be overweight while decreasing the time necessary to process the majority of trucks on the highway. The analysis along with other enforcement planning and screening exercises begins later in the study.

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BRIDGE WIM SYSTEM FUNCTIONAL CHARACTERISTICS

For planning purposes, the BWIM system can be set up on concrete and steel girdered bridges that are accessible from underneath. The skew angle (where roadway and bridge meet) should be less than 40° and the length of the bridge span should be between 30'-90'. The system itself consists of sets of strain gauges which are placed on the support beams of bridges. The electronic gauges are attached by wires to an elaborate computer system housed in a van which is parked and hidden underneath the bridge if possible. The computer uses strain measurements from the bridge and input from tapeswitch axle sensors on the roadway to classify and weigh each passing truck.

Calibration Procedure

Before operations can take place, an influence line of the bridge must be created. A mathematical process which calculates vehicle weights uses the influence line for the bending moment (flex) in the bridge girders at the location of the strain transducers. In addition, each bridge must then be properly calibrated with the use of a weighted test truck. A test vehicle (county dump truck) with a known weight of 40,000 or more pounds is required to cross the BWIM location a minimum of six times in each lane. These crossings are essential to assure proper weighting factors and samples are calculated in the BWIM computer program disk for each lane of traffic. The entire process requires approximately two or more hours depending upon the distance involved for each test truck crossing.

Set Up And Take Down

To fully set up and take down the equipment requires approximately one hour depending upon circumstances unique to each bridge site. Once installed, features such as the tapeswitch coverings on the roadway and strain gauge connections under the bridge can remain in place if the possibility of vandalism is remote. This eliminates a portion of the time needed to set up and take down while allowing extended data collection periods. One complete set of electronic BWIM equipment is all that is needed to move from one bridge site to another. This holds overall operating costs to a minimum, especially when compared to some of the other WIM system operations which are, for practical purposes, permanent and require one complete system for each site investigated. Of course, two people who are well trained in all areas of the system are also required for on-site operations. The complete bridge WIM system including all necessary computer and electronic equipment along with a van to house the apparatus costs in the neighborhood of $120,000.

Operating Costs

Overall operating costs of conducting a new Truck Weight Study using the BWIM are less than if the original TWS program were maintained. Even though the number of stations per year has increased along with year round operations becoming essential at selected locations, long term operating costs from FY 83-88 will be substantially lower due to a sizable reduction in the need to hire Limited Term Employees. Beginning with FY85, total In-House and LTE operating costs for the current TWS program are $128,000 compared to $165,000 for reinstituting the original program during the next four-year period. An annual costs chart of the Truck Weight Study Program was developed two years ago and is contained in Appendix I. At this time there is no reason to consider making any significant changes to its content.

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CAPABILITIES AND ACCURACY OF THE BWIM SYSTEM

In addition to collecting Truck Weight Study data at several locations in Wisconsin, efforts of the Bridge WIM System's crew concentrated on conducting accuracy tests of the WIM System's vehicle weight categories. Bridge WIM operations were set up and accuracy test comparisons were performed at four separate locations throughout the state in an attempt to determine the precision of the system's weight measurement capabilities. Vehicles were randomly selected for weighing on the bridge WIM and then weighed at permanent scale sites for comparison purposes. The entire operation required patience and coordination between the WIM crew operators and the enforcement officers at each scale site. Sites were selected based upon their close proximity to permanent weighing facilities and also to provide a representative sample of various types of bridge configurations. Each of the following bridge sites selected represent either prestressed concrete or steel deck girder configurations along with varying skew angles and span lengths.

BRIDGE	SKEW<	SPAN LGT.	TYPE
I-90 EB over CTH M near West Salem	35°	39.5'	Steel Deck Girder
USH 51 NB over STH 66 near Stevens Point	9°	77'	Prestressed Conc.
I-43 SB over CTH C near Newton	31°	95.5'	Prestressed Conc.
I-90 WB over CTH B near Utica	44°	46'	Steel Deck Girder

As stated in the National Bureau of Standards Handbook 44, the basic maintenance tolerance for all vehicle scales is 2 pounds per 1000 pounds of test load (0.2 percent). The acceptance tolerance is one-half the basic maintenance tolerance or 0.1 percent. Acceptance tolerances apply to any equipment about to be put into commercial use for the first time or equipment that is being officially tested for the first time within 30 days after major reconditioning or overhaul. The permanent scales used for the accuracy tests conform to the above federal requirements and were certified by the Department of Agriculture, Trade, and Consumer Protection on the following dates.

SCALE SITE	DATE CERTIFIED
West Salem	May 2, 1984
Stevens Point	July 28, 1983
Newton	September 14, 1982
Utica	January 31, 1984

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Tabular Count and Percentage Breakdown

The following is a tabulation of the trucks that were weighed using both the Bridge WIM and static enforcement scales. Identical matches were obtained for a total of 313 trucks across all four sites. In the table vehicles are categorized by location, type of axle grouping, weight in terms of the percent difference from the actual weight, and those vehicles weighing over and under 40,000 pounds. Under samples in parentheses are those 2 single and 3 combo or single axle vehicles collected at each site. Subsequently over 85% of all vehicles collected are composed of 3S-2, 2S-2, 4 combo and other 4 axle or more truck combinations with the majority being of the 3S-2 variety. This is the initial tabulation of all random traffic stream accuracy data from which other tables and graphs in this section are derived.

TABLE A

TRUCK TABULATIONS

		VEHICLES <40,000#					VEHICLES >40,000#				
	SAMPLES	<5%	5-10%	10-15%	15-20%	>20%	<5%	5-10%	10-15%	15-20%	>20%
STEERING WEIGHT											
West Salem	89(5)	4	5	8	8	15	10	12	7	9	11
Stevens Point	55(14)	11	5	6	5	9	5	5	1	1	7
Newton	118(20)	6	6	14	10	33	10	13	8	4	14
Utica	51(2)	6	2	3	1	5	9	11	5	6	3
DRIVE WEIGHT											
West Salem	89(5)	11	10	5	5	9	25	15	7	1	1
Stevens Point	55(14)	8	9	2	4	13	9	9	-	-	1
Newton	118(20)	14	14	9	9	23	19	10	6	9	5
Utica	51(2)	1	1	5	3	7	9	9	10	5	1
TRAILER WEIGHT											
West Salem	84	13	9	10	2	1	20	23	5	1	-
Stevens Point	41	7	9	3	2	2	11	4	1	2	-
Newton	98	7	20	10	2	12	18	16	5	5	3
Utica	49	8	2	1	2	2	8	6	3	4	13
GROSS WEIGHT											
West Salem	89(5)	26	10	3	1	-	43	6	-	-	-
Stevens Point	55(14)	12	15	6	3	-	16	2	-	-	1
Newton	118(20)	40	21	5	2	1	33	15	1	-	-
Utica	51(2)	8	4	4	-	1	13	5	5	6	5

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In order to facilitate working with the figures contained in Table A, the results of all vehicles have been changed to percent in Table B. Depending upon which specific site and axle grouping desired, one can determine the percent of vehicles found in any given range of error. Cumulative totals have also been included in parentheses. Using the following statement, substitutions can be made in the underlined spaces to signify each specific site and axle weight grouping.

Of all vehicles collected at West Salem, 77.5% are within ±5% of the actual gross weight.

TABLE B

RANGE OF ERROR

		<±5%	±5-10%	±10-15%	±15-20%	>±20%
	STEERING	15.7	19.1(34.8)	16.9(51.7)	19.1(70.8)	29.2(100)
WEST	DRIVE	40.5	28.1(68.6)	13.5(82.1)	6.7(88.8)	11.2(100)
SALEM	TRAILER	39.2	38.1(78.3)	17.9(96.2)	3.6(98.8)	1.2(100)
	GROSS	77.5	18.0(95.5)	3.3(98.8)	1.2(100)	
	STEERING	29.1	18.2(47.3)	12.7(60.0)	10.9(70.9)	29.1(100)
STEVENS	DRIVE	30.9	32.7(63.6)	3.6(67.2)	7.3(74.5)	25.5(100)
POINT	TRAILER	43.9	31.7(75.6)	9.8(85.4)	9.7(95.1)	4.9(100)
	GROSS	50.9	30.9(81.8)	10.9(92.7)	5.5(98.2)	1.8(100)
	STEERING	13.6	16.1(29.7)	18.6(48.3)	11.9(60.2)	39.8(100)
NEWTON	DRIVE	28.0	20.3(48.3)	12.7(61.0)	15.3(76.3)	23.7(100)
	TRAILER	25.5	36.7(62.2)	15.3(77.5)	7.2(84.7)	15.3(100)
	GROSS	61.9	30.5(92.4)	5.1(97.5)	1.7(99.2)	0.8(100)
	STEERING	29.4	25.5(54.9)	15.7(70.6)	13.7(84.3)	15.7(100)
UTICA	DRIVE	19.6	19.6(39.2)	29.4(68.6)	15.7(84.3)	15.7(100)
	TRAILER	32.7	16.3(49.0)	8.2(57.2)	12.2(69.4)	30.6(100)
	GROSS	41.2	17.6(58.8)	17.6(76.4)	11.8(88.2)	11.8(100)
	STEERING	19.5	18.8(38.3)	16.6(54.9)	14.1(69.0)	31.0(100)
ALL	DRIVE	30.7	24.6(55.3)	14.1(69.4)	11.5(80.9)	19.1(100)
SITES	TRAILER	33.8	32.7(66.5)	14.0(80.5)	7.4(87.9)	12.1(100)
COMBINED	GROSS	61.0	24.9(85.9)	7.7(93.6)	3.8(97.4)	2.6(100)
ALL	STEERING	17.6	17.6(35.2)	16.8(52.0)	14.1(66.1)	33.9(100)
SITES	DRIVE	32.8	25.6(58.4)	11.1(69.5)	10.7(80.2)	19.8(100)
WITHOUT	TRAILER	34.1	36.3(70.4)	15.2(85.6)	6.3(91.9)	8.1(100)
UTICA	GROSS	64.9	26.3(91.2)	5.7(96.9)	2.3(99.2)	0.8(100)

( ) CUMULATIVE TOTAL

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In some instances, the Utica accuracy test results should be excluded from the rest of the findings. The Utica bridge site has a skew angle of 44° which is larger than WIM operations require. The vendor of the bridge WIM equipment has stated that results become increasingly inaccurate when bridges of greater than 40° skew angles are used. Our tests included a bridge of this type to examine how inaccurate these results might be. As you can see, the results recorded at Utica are the least accurate of the four sites.

Standard Deviation and Confidence Levels

Another important accuracy measurement involves the use of the standard deviation. This statistical measure helps to explain the range or confidence level for each individual axle weight category. By taking the standard deviation of the difference of a specific weight (gross, steering, drive, trailer) and dividing by the mean static weight for the equivalent weight group, a unitless (percent) measure called the coefficient of variation is produced. The lower the coefficient of variation, the smaller the range of error or variance from the mean and consequently more accurate results. In most cases the variance is least accurate for steering axles while gross weights prove to be the most accurate. The coefficient of variation numbers at one standard deviation have been calculated for all axle groups at all sites individually as well as combined in Table C. To use these figures simply substitute the desired location and axle configuration in the following statement.

Assuming a normal distribution, 68.0% of the trucks at (SITE) are within ± __ % of the static (TYPE) weight when compared to the mean static (TYPE) weight.

TABLE C

COEFFICIENTS OF VARIATION FOR ACCURACY SITES

TYPE WEIGHT	WEST SALEM	STEVENS POINT	NEWTON	UTICA	ALL SITES COMBINED	ALL SITES EXCEPT UTICA
STEERING	20.6	16.6	21.3	19.5	21.1	21.5
DRIVE	7.6	12.1	14.3	13.2	12.6	11.4
TRAILER	5.5	8.5	13.5	20.3	14.0	10.2
GROSS	3.5	5.8	5.9	11.3	8.0	5.0

Looking at all sites combined with the exception of Utica (262 samples), roughly two-thirds of all vehicles weighed using the bridge WIM system will be within ±5% of the static gross weight when compared to the mean static gross weight. Of course that also assumes that nearly one-third of those weighed will fall somewhere outside that range.

The coefficent of variation has also been separated into those vehicles weighing less than and greater than 40,000 pounds in Table D. In almost all cases, the heavier vehicles have a lower or more accurate reading. Underlined figures represent those axle group categories which are less accurate at heavier weights.

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TABLE D

COEFFICIENTS OF VARIATION AT <AND> 40,000#

	WEST SALEM	STEVENS POINT	NEWTON	UTICA	ALL SITES COMBINED	ALL SITES EXCEPT UTICA
<40,000#						
STEERING	24.4	18.0	24.0	29.8	25.3	24.6
DRIVE	15.6	14.6	15.9	22.5	16.5	15.7
TRAILER	8.5	10.3	12.2	16.4	13.6	13.1
GROSS	4.1	4.1	5.2	10.1	5.9	4.8
>40,000#						
STEERING	18.0	14.1	17.8	13.0	17.1	18.2
DRIVE	4.9	8.6	12.5	9.7	10.2	8.9
TRAILER	3.5	6.7	11.5	17.5	11.5	7.7
GROSS	2.9	5.1	5.2	9.5	7.0	4.2

In addition to the coefficients of variation at one standard deviation, a Z factor can be used to derive other confidence levels. Some Z factors and corresponding levels of confidence are listed below.

Z FACTOR	CONFIDENCE LEVEL
1.00	68.0%
1.28	80.0%
1.64	90.0%

By multiplying the appropriate Z factor and coefficient of variation one can obtain the desired confidence level. For instance, the coefficient of variation x 1.64 = the precision level at 90% confidence. Table E displays the results at both the 80% and 90% confidence levels for all sites. This information can be applied to the normal distribution statement from the previous page.

TABLE E

PERCENT ERROR AT THE 80% CONFIDENCE LEVEL

	WEST SALEM	STEVENS POINT	NEWTON	UTICA	ALL SITES COMBINED	ALL SITES EXCEPT UTICA
STEERING	26.4	21.2	27.3	25.0	27.0	27.5
DRIVE	9.7	15.5	18.3	16.9	16.1	14.6
TRAILER	7.0	10.9	17.3	26.0	17.9	13.1
GROSS	4.5	7.4	7.6	14.5	10.2	6.4

PERCENT ERROR AT THE 90% CONFIDENCE LEVEL

	WEST SALEM	STEVENS POINT	NEWTON	UTICA	ALL SITES COMBINED	ALL SITES EXCEPT UTICA
STEERING	33.8	27.3	34.9	32.0	34.6	35.3
DRIVE	12.5	19.9	23.5	21.7	20.7	18.7
TRAILER	9.0	13.9	22.1	33.3	23.0	16.7
GROSS	5.7	9.5	9.7	18.5	13.1	8.2

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Vehicle Speeds Relative to Weight

Vehicle speeds also appear to have a direct relationship on the accuracy level of each site and are therefore included for comparison purposes. The standard deviation formula reveals that the rank order of accuracy on gross weight in comparison to the mean speed is as follows.

RANK ORDER	SAMPLES	C.V.	MEAN SPEED
1 WSM	89	3.5	41.8
2 STP	55	5.8	57.9
3 NWT	118	5.9	56.9
4 UTC	51	11.3	58.2

The slower speeds were recorded at West Salem due to the permanent scale sites close proximity to the bridge WIM location. West Salem also happens to have the most accurate gross vehicle weight results. Of the many variables associated with the bridge WIM system, speed in comparison to accuracy has been quantified at the four sites. The above results indicate the system operates more accurately when vehicles are running at slower speeds. However, these findings require more accuracy testing to fully substantiate since there are other variables that may cause discrepancies from one site to another. Therefore, another approach to investigating the relationship between accuracy and speed such as plotting each vehicle's absolute error with the same vehicle's speed at all sites has been examined (Please refer to Appendix II).

As presented in Appendix II, each vehicle sample's gross weight absolute error versus speed and gross weight percent error versus speed has been plotted on the diagrams. These results have been further broken down to exclude those samples collected at the Utica site which includes factors unacceptable for bridge WIM use. In all graphs, a heavy concentration of vehicles appears throughout the 50-62 mph range with a lesser density representing several West Salem samples in the 34-44 mph range. When analyzing the absolute and percentage charts for all samples, a large variance is found in the 50-62 mph range with some samples approaching inaccuracy levels of as high as ±30%. By removing the Utica site samples the inaccuracy levels are reduced to near ±10% within the 50-62 mph range. However, the level of inaccuracy is consistently less than ±5% in the 34-44 mph range for both procedures. Considering the number of samples collected, of which fewer than 30% are within the 34-44 mph range, a pattern of greater inaccuracy at increasing speed levels does become visible.

Systematic Bias and Absolute Errors

To find out whether a pattern of systematic bias exists, the mean differences of all sites and axle categories are listed in Table F. This table assists in explaining whether the bridge WIM system consistently weighs high or low at different locations or among certain axle groupings. As proven in the analysis, the drive axles are consistently weighed low while in most cases the trailer axles are weighed higher than their actual weight. At most sites gross weight was underweighed on lighter weight vehicles and overweighed on heavier vehicles.

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TABLE F

MEAN DIFFERENCES OF ALL VEHICLES

	WEST SALEM	STEVENS POINT	NEWTON	UTICA	ALL SITES COMBINED	ALL SITES EXCEPT UTICA
STEERING	-209	-251	1126	671	430	384
DRIVE	-1269	-1409	-1142	1169	-849	-1241
TRAILER	1152	634	-304	2665	822	417
GROSS	-384	-1187	-264	4416	302	-498
			VEHICLES <40,000#			
STEERING	-470	-42	1272	1200	543	466
DRIVE	-970	-1975	-1414	-700	-1354	-1431
TRAILER	349	248	-1129	-140	-337	-364
GROSS	-1157	-1850	-987	400	-1075	-1248
			VEHICLES >40,000#			
STEERING	4	-647	920	406	310	282
DRIVE	-1512	-337	-759	2103	-306	-1006
TRAILER	1727	1128	591	3903	1793	1164
GROSS	247	68	755	6424	1780	431

Following are the mean absolute errors and mean absolute percentage errors for all sites and axle groupings. These results provide the average error of each axle grouping inconsiderate of whether the system is under or overweighing. In other words, how far off on average, in total weight and percent, are the accuracy results. The percent is listed next to each individual mean absolute error in Table G. Results follow a similar pattern established in prior analysis.

TABLE G

MEAN ABSOLUTE ERRORS AND MEAN ABSOLUTE PERCENTAGE ERRORS

	WEST SALEM	STEVENS POINT	NEWTON	UTICA	ALL SITES COMBINED	ALL SITES EXCEPT UTICA
STEERING	1582(17.8)	1149(14.1)	1769(21.9)	1325(14.1)	1535(18.1)	1575(18.9)
DRIVE	1693(9.2)	1976(14.0)	2183(14.4)	2651(13.6)	2084(12.7)	1973(12.6)
TRAILER	1364(6.9)	1044(8.4)	1667(11.2)	3392(14.5)	1790(10.1)	1439(9.1)
GROSS	1467(3.5)	1951(6.4)	1764(4.6)	5369(9.3)	2300(5.4)	1702(4.6)
			VEHICLES <40,000#			
STEERING	1720(21.6)	1114(15.2)	1986(26.3)	1882(20.9)	1715(22.1)	1696(22.2)
DRIVE	1620(13.5)	2047(17.7)	1954(17.9)	2429(21.0)	1942(17.1)	1885(16.6)
TRAILER	743(7.9)	770(10.4)	1322(13.6)	1113(11.2)	1031(11.1)	1019(11.1)
GROSS	1382(5.2)	1850(7.6)	1355(5.3)	2282(7.5)	1569(6.0)	1486(5.8)
			VEHICLES >40,000#			
STEERING	1469(14.8)	1216(12.1)	1463(15.8)	1047(10.7)	1340(13.8)	1426(14.8)
DRIVE	1753(5.8)	1842(6.9)	2506(9.5)	2762(9.9)	2236(8.1)	2083(7.5)
TRAILER	1808(6.2)	1394(5.9)	2043(8.6)	4397(16.0)	2427(9.2)	1839(7.1)
GROSS	1537(2.2)	2142(4.0)	2339(3.7)	6912(10.3)	3083(4.7)	1971(3.1)

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Graphs and Individual Comparisons

Each individual truck sample collected in the test is contained in a one-to-one format in Appendix III. The static (S) scale vs. WIM (W) scale accuracy comparisons are shown for the steering, drive tandem, trailer tandem, and gross vehicle weight. Included in the columns from left to right are: OBS = observations, TRKTYPE = truck type, SSWGT = static steering weight, WSWGT = WIM steering weight, SDWGT = static drive weight, WDWGT = WIM drive weight, STWGT = static trailer weight, WTWGT = WIM trailer weight, SGWGT = static gross weight, WGWGT = WIM gross weight, SITE with LAX representing West salem, MNC representing Newton, STP representing Stevens Point, and UTC representing Utica, DIFFG = difference in gross weight, PDIFG = percent difference in gross weight. All weights represent thousands of pounds.

To assist in presenting the results graphically, the static scale weights versus the WIM scale weights across all sites as well as individual sites have been plotted on charts contained in Appendix IV. Note the large variance in steering weights along with minor variances in gross weights.

Appendix V contains bar graphs of all gross vehicle weights collected. They have been separated into the bridge WIM and static weight categories for all sites as well as individual sites. Static and WIM gross weights have also been separated into only 3S-2 trucks with LAX representing West Salem, MNC representing Newton, STP representing Stevens Point and UTC representing Utica. The chart shows the percentage for each midpoint of a 10,000 pound range. All columns of each chart will total to be 100%.

Girderless Bridge Experiment

At the request of representatives from Bridge Weighing Systems, Inc., the bridge WIM crew set up and conducted an accuracy test on a haunched slab concrete bridge with a low skew angle. The site selected was at the I-94 over CTH N interchange near Cottage Grove and had a skew angle of 10° and span length of 33.5'. To the best of anyone's knowledge, this was the first time a girderless bridge was ever used for the purpose of weighing trucks. With the use of a power drill, strain gauges were connected to the underside of the bridge at the same measurements normally used on girdered bridges. During the test, 35 samples were correctly matched using a nearby permanent scale. After analyzing the data, final examination showed that the steering coefficient of variation of ±12.9% at Cottage Grove was much more accurate than any of the previously analyzed test sites (see Table C). The drive and trailer tandem coefficients of variation along with the ±12.6% gross weight reading were not nearly as close to those in Table C, however. Although more testing is required on these types of concrete slab bridges, the following coefficient of variation results from Cottage Grove indicate that the potential exists for future use of similar type bridges.

COEFFICIENTS OF VARIATION FOR COTTAGE GROVE

	35 SAMPLES	<40,000#(22)	<40,000#(13)
STEERING	12.9	14.9	10.6
DRIVE	13.7	16.8	9.4
TRAILER	17.7	15.9	12.5
GROSS	12.6	13.3	9.5

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Overview

This section provides an overview of the WIM system accuracy tests conducted near five separate permanent scale sites in Wisconsin. Results of these tests have been broken down and presented in several diverse ways. Of course there are still other statistical procedures available to interpret, present or investigate additional insights within the study and methods chosen here are not considered the only means of analyzing comparison data.

Whether or not these results answer all the questions surrounding the bridge WIM system depends a great deal upon what the equipment is to be used for. If the system is used for the purpose of collecting planning related data such as the type and approximate weight of vehicles utilizing specific functional class highways at any given time of day, week, month or season, then it has proved to be more than beneficial in acquiring such information. If the system is needed for enforcement purposes such as screening individual motor carriers for precise weights of the steering, drive tandem and trailer tandem axles along with the gross vehicle weight for each passing truck, then many improvements in the technical aspects of the system are essential before such activity can take place.

However, other enforcement planning efforts such as collecting truck weight data near permanent scale facilities when they are open ("abnormal roadwear") and closed ("normal roadwear") could be very useful. This type of comparison can provide a picture of the truck patterns when the scales are not open and assist in the development of selective enforcement plans for the surrounding area. Other such uses include screening specific truck routes when known heavily loaded and overloaded vehicles are operating. These types of enforcement planning activities were conducted during the latter part of 1984 and the results are contained in a succeeding chapter.

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INDIVIDUAL BWIM PROCESS PROGRAMS

Our analysis went a step further by exploring the potential differences in accuracy test results among the BWIM field program, process program and a reprocess program which incorporated modified weighting factors in the calibration process. The bridge WIM computer calculations for both the field program (original girder strain values) and process program (original girder strain values processed in-house) should be identical since the same weighting factors are used for each. However, in many instances, each field program sites individual axle and gross vehicle weight coefficient of variation was altered somewhat when using the process program. No explanation could be given as to why this occurred. Originally a matrix method developed by personnel in the data development section was used to arrive at the proper weighting factors for each site. This statistical method was used in both the field and process programs.

In another approach to discovering ways to improve the accuracy test figures, a new set of weighting factors was developed using a separate method created by the manufacturer. Recognized as a "reprocess program", this procedure was responsible for producing more ameloriative C.V. results. Many of the improvements found throughout the analysis, however, were not significant enough to make a statement indicating that the reprocess program was the unequivocal choice in BWIM programs. Nevertheless, our investigation presented improved results in 16 of 24 (2/3) categories when using the reprocess program for all sites combined. Final results follow in Table H for all three BWIM programs with underlined figures representing the leading or "best" C.V. and an * which delineates equal value.

TABLE H

COEFFICIENTS OF VARIATION FOR ALL THREE BWIM PROGRAMS

ALL SAMPLES		WEST SALEM	STEVENS POINT	NEWTON	UTICA	ALL SITES COMBINED	ALL SITES EXCEPT UTICA
FIELD	STEERING	20.6	16.6	21.3	19.5	21.1	21.5
	DRIVE	7.6	12.1	14.3	13.2	12.6	11.4
	TRAILER	5.5	8.5	13.5	20.3	14.0	10.2
	GROSS	3.5	5.8	5.9	11.3	8.0	5.0
PROCESS	STEERING	14.6	16.8	19.8	19.0	20.8	20.8
	DRIVE	7.7	10.9	14.1	13.0	13.6	12.6
	TRAILER	4.6	12.0	13.8	20.5	14.8	11.4
	GROSS	3.2	*5.4	5.8	12.3	8.7	4.9
REPROCESS	STEERING	12.4	18.2	17.3	16.6	16.4	16.3
	DRIVE	6.2	11.2	13.0	13.9	13.2	11.0
	TRAILER	5.3	10.5	12.4	17.1	12.2	9.6
	GROSS	4.3	*5.4	4.6	11.9	7.9	4.7

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The process and reprocess program results have also been tabulated for those vehicles less than and greater than 40,000 pounds. For vehicles less than 40,000 pounds, the reprocess program has nearly 60% of the most improved coefficients of variation. The field and reprocess programs have about the same number of improved coefficients for vehicles greater than 40,000 pounds. The following process and reprocess coefficients of variation for vehicles less and greater than 40,000 pounds in Table I can be compared to the field results located in Table D.

TABLE I

PROCESS AND REPROCESS COEFFICIENTS OF VARIATION AT <AND>40,000#

<40,000#		WEST SALEM	STEVENS POINT	NEWTON	UTICA	ALL SITES COMBINED	ALL SITES EXCEPT UTICA
	STEERING	14.0	18.2	22.2	23.0	23.6	23.3
PROCESS	DRIVE	10.1	13.0	14.2	17.1	16.4	16.3
	TRAILER	5.6	14.8	11.5	16.8	15.3	15.1
	GROSS	4.0	4.1	4.8	10.6	6.3	5.0
	STEERING	12.5	18.4	17.1	18.3	17.6	16.3
REPROCESS	DRIVE	10.4	13.6	13.1	19.8	15.8	14.0
	TRAILER	6.9	13.2	11.9	11.9	11.7	11.7
	GROSS	5.4	3.8	5.0	8.6	5.7	5.0
>40,000#							
	STEERING	14.7	15.0	16.9	17.2	18.2	18.2
PROCESS	DRIVE	6.4	8.7	12.9	9.7	11.6	10.3
	TRAILER	3.2	7.4	12.0	17.5	12.0	8.5
	GROSS	2.7	4.7	5.2	10.2	7.7	4.1
	STEERING	11.5	18.0	17.4	13.1	15.5	16.1
REPROCESS	DRIVE	4.9	8.9	12.0	12.1	11.4	9.1
	TRAILER	4.3	7.1	10.3	15.4	10.3	7.6
	GROSS	3.8	4.8	3.6	10.3	7.2	4.1

CLASSIFICATION, AXLE SPACING AND SPEED MEASUREMENTS

During the course of the RTAP project, another series of special verification tests were conducted to assess the capabilities of the bridge WIM system's classification, axle spacing and speed categories. These sections were individually examined and then compared to each specific examples actual occurrence. Because of its accessible location, all of the test procedures took place at the USH 18-151 over Fitchrona Rd. bridge site near Verona.

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Classification

The bridge WIM system's ability to correctly classify vehicles at various ranges of traffic speed was tested by an observer. Major emphasis was placed upon the system's ability to distinguish between cars and trucks as well as classification of select vehicles into the correct axle configuration category. The percent of vehicles correctly classified was used to measure performance. In our investigation a total of 150 trucks were sampled (75 eastbound and 75 westbound). Of that figure, 71 westbound and 72 eastbound samples were perfectly matched between the BWIM and the observer. That left a total of seven or less than 5% which were incorrectly recorded. More importantly, a success rate of greater than 95% was attained through the survey. Put another way, on average slightly better than 19 of 20 vehicles were properly classified. No problems were found distinguishing cars from trucks.

Axle Spacing

Also at Verona, 199 vehicles were checked to determine the accuracy and reliability of the BWIM when measuring axle spacings of multiple axle vehicles. Of that total the majority (94) were 5-axle vehicles. The remaining 105 trucks were split among 2,3 and 4 axle configurations. Using the same formula described previously, coefficients of variation were developed for all spacing measurements between axles. In our analysis the more lengthy measurements were found to be more accurate. Those spacings between the length of the cab (steering-first drive tandem) and the length of the trailer (second drive tandem-first trailer tandem) had coefficients of variation of as low as ±2.0% and ±1.1% respectively. The tandem axle C.V.'s were calculated at ±5% on the drive axles and ±3.8% on the trailer axles. Most of the tandem distances were in the area of 4'. When using this method of analysis, total distance plays an important role in the final results. For instance, if the absolute error is the same for both a 4 foot and a 28 foot measurement, a much lower C.V. will be calculated on the 28 foot spacing. This is true of any analysis which incorporates percentage as a means of computing a final product. However considering the relatively low coefficients of variation for all axle space groupings, near precise results can be expected. Axle spacing samples and configurations in comparison to the C.V. follow.

	SAMPLES	C.V.	MEAN DISTANCE
Axle Space 1-2 (cab)	199	±2.0%	13.2'
Axle Space 2-3 (drive tandem)	168	±5.0%	7.4'
Axle Space 3-4 (trailer)	117	±1.1%	23.9'
Axle Space 4-5 (trailer tandem)	94	±3.8%	4.1'

Vehicle Speeds

Another important BWIM category which was analyzed involved vehicle speeds. Using an officially certified radar gun, a system of accurately checking the speeds of selected auto and truck traffic was developed. With the BWIM equipment in place and normal data collection activities going on, two additional people were required to record the speeds of vehicles from both the radar gun and the BWIM. One person was responsible for recording vehicle speeds with the radar gun while the other person was located in the van recording the WIM and radar speeds for the same vehicle. Both people were able to communciate to each other with hand held CB radios.

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In the survey, a total of 215 samples (150 in lane 1 and 65 in lane 2) were collected. After applying the identical standard deviation formula which was used in the axle weight and spacing computations, coefficients of variation for speed were similarly developed. The results at one standard deviation confirm that 68% of the samples at Verona were within ±2.8% of the radar speed. When the total amount is separated by lane of travel, the figures convert to ±3.0% for lane 1 and ±2.5% for lane 2. As in previous testing procedures the 68% infers that better than 2 out of 3 vehicles are within the percentage or C.V. listed. In actuality, a vehicle travelling in lane 1 which registers at 55 MPH on the BWIM has a high probability of being between 53.35 and 56.65 MPH. Overall these figures support the contention that BWIM measured speeds are reasonably accurate.

Using a telemetry station's speed recordings as a base scale, we were also able to determine whether there is a discernible difference in speeds recorded at a telemetry site versus speeds recorded at a typical WIM site. To accomplish this task, one of the bridge WIM key pad operators was stationed near a telemetry station site which could also possibly serve as a bridge WIM site for a period of two hours. Speed recordings received at the telemetry station for this same two hour period on other days were compared to those recorded during the test. As a result, we were then able to determine whether or not the key pad operator's presence on the highway has a direct effect on vehicle speed.

The two hour testing was held on an autumn Wednesday afternoon near a telemetry station at Johnson Creek. This information was compared to data recorded at the same site and time on the preceding Tuesday, following Thursday and Wednesday of the following week. The percentage of traffic recorded in all speed ranges follows.

KEY PAD OPERATOR'S EFFECT ON VEHICLE SPEEDS

Time period of 2-4 PM Used Throughout

Speed Range	Tuesday	Wednesday	Thursday	Next Wednesday
36-43 MPH	.7%	.5%	1.0%	.4%
44-49 MPH	4.5%	4.9%	7.0%	4.0%
50-53 MPH	14.5%	12.5%	15.2%	15.0%
54-55 MPH	14.0%	16.0%	13.6%	17.5%
56-57 MPH	23.2%	23.5%	20.8%	23.7%
58-61 MPH	33.2%	33.3%	30.8%	23.8%
62-67 MPH	9.5%	8.8%	10.7%	15.0%
68-75 MPH	.4%	.5%	.9%	.6%
	100.0%	100.0%	100.0%	100.0%

The control period on Wednesday in the second column has been compared to the same period on the days previously mentioned. Some of the noticeable characteristics during the test include a higher percentage at the 54-55 MPH range compared to the surrounding days and the lowest percentage of all four days at the 62-67 MPH range. This supports the opinion that a slightly higher percentage of motorists obey the 55 MPH limit and a slightly lower percentage travel at the mid-60 MPH range when an attendant is standing near the roadway.

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BWIM ENFORCEMENT PLANNING AND SCREENING

The Division of Planning and Budget (DPB) has continued to cooperate with the Division of State Patrol (DSP) for the purpose of using the BWIM in specific enforcement planning and screening activities. Because the accuracy level is known at each of the four bridges used in the original tests, the DSP proposed undertaking specialized enforcement planning activities at some of those sites which may assist in the development of selective enforcement plans for scale facilities. During the earlier accuracy test period, permanent scale facilities were open and State Patrol personnel were conducting enforcement activities in the general test area. Subsequently, truck traffic data collected for that specific time frame is considered biased or "abnormal" traffic flow. "Abnormal" refers to truck traffic data collection when a nearby scale is open, a lodec portable scale is being operated, or inspectors in wing crews are removing possible overweight trucks in the general area. Since the bridge near West Salem had recently been reconditioned and resurfaced and the Utica site was found to be exceedingly inaccurate due to several factors, a decision was made to collect truck traffic data at the Stevens Point and Newton sites with no enforcement present. Truck traffic data collected with the scales closed is considered "normal" traffic flow and is categorized as such when enforcement operations are nonexistent. Our tests involved comparing what was collected at the "abnormal" traffic flow period with data collected during a "normal" period to determine what types of truck patterns, if any, appear when the scales are not open. These "normal/abnormal" conditions were tested on the same route as the previous enforcement weighings while no "normal/abnormal" conditions were measured on parallel or bypass routes.

Reexamination of Original Test Sites

The BWIM crew spent a comparable amount of time to the original "abnormal" test periods at both the Stevens Point and Newton sites. During "normal" operation a total of 207 trucks were collected on the BWIM at Stevens Point with 79 vehicles being estimated as the number of loaded semis (>40,000 pounds). Of that amount, 4 were recorded as being in excess of 80,000 pounds. If we apply the ±5.8% coefficient of variation on gross weight which was established in the original test at Stevens Point, the possibility exists for the 17 vehicles recorded at the 75-80,000 pound range to be overweight. However, all five vehicles which were screened and brought in for accuracy checking at the permanent scale during the most recent test were found to be within ±2,000 pounds on gross weight. Through the use of this selection method we can then assume that nearly 14%, or 11 of the 79 loaded vehicles which either exceeded or were recorded within 2000 pounds of the maximum weight limit at Stevens Point have the potential of being overweight. In other words, 14% of the loaded semis could be considered possible overloads.

Eleven of the 365 vehicles which were collected at Newton using the same criteria and procedures as Stevens Point registered at over 80,000 pounds. Of that total 162 were considered to be loaded semis. Again applying the ±5.9% coefficient of variation for Newton which was established in previous testing, 22 vehicles were found to be in the 75-80,000 pound range. Select vehicles which were screened on the BWIM weighed within ±4000 pounds on gross at the permanent scale. Consequently, almost 18% (29 of 162) of the loaded vehicles weighed could possibly be overweight using this method at Newton. Remember, this percentage represents all vehicles which fall within or exceed ±4000 pounds of the maximum gross weight limit of 80,000 pounds.

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This analysis has shown that we can assume during the daylight hours of any given regular weekday, a moderate percentage (14-18%) of the loaded trucks at these two locations are travelling with what can be considered potential overweight loads. These potential or "normal" statistics are fairly substantial, especially when compared to the "abnormal" collection period which was termed "very quiet" as far as the number of recorded gross overweight trucks is concerned. While this investigation does not incorporate the identical criteria used by the General Accounting Office to average the number of loaded trucks which exceed state weight limits, it does provide a basis from which estimates of the overweight truck question can be developed. Another consideration to be made in the analysis is the fact that much of Wisconsin's truck traffic and related industries are concentrated in the southeastern and south central part of the state; a distance several miles from where our testing was conducted. Subsequently, the potential certainly exists for these percentages to increase on major thoroughfares located in these other regional areas.

Seasonal Enforcement Experiments

In addition to the activities at Stevens Point and Newton, DP&B and State Patrol representatives coordinated three enforcement experiments involving seasonal motor carrier overloads. Because of the inconsistency in the results of the original four site accuracy test, the State Patrol cannot easily use the BWIM on highways that carry "normal" weight trucks. Officers must have "probable cause" to stop and weigh a truck and the accuracy level of the BWIM does not provide enough confidence in each individual computation. The following three sites were selected on highways which are known to receive overloaded vehicles on a seasonal basis.

BRIDGE	SKEW<	SPAN LGT.	TYPE
STH 78 SB over USH 51 SB near Portage	31°	39'	Concrete Deck Girder
USH 8-45 over CNW RR near Monico	30°	45'	Steel Deck Girder
I-90 EB over STH 162 near Bangor	0°	31'	Steel Deck Girder

A site north of Portage was selected in early autumn to observe potato and other similar motor carriers travelling between central Wisconsin and the interstate system south of the city. "Potato haulers" have been notorious for transporting overloaded agricultural commodity shipments during this season of the year and for that reason a weekly study of the trucking patterns was conducted. Similar weekly schedules were also planned and conducted at the two remaining bridge locations. Monico was selected because of its central location within Wisconsin's timber and pulpwood industry. Several area pulpwood trucking firms use USH 8 and 45 to transport their forest products to paper mills located south and west of this region. In the past, some of these loads have been recorded at over 100,000 pounds. The bridge location on an interstate highway east of La Crosse near Bangor represents a sampling of the truck traffic entering Wisconsin from a neighboring state. This "port of entry" observation was also conducted to reveal any relative trucking patterns or trends which may or may not exist.

Our testing procedures required "normal" truck traffic data collection early in the week with no enforcement present. On each Wednesday, portable lodec scales were used at a nearby location to conduct an accuracy test of the bridge. The data collected was then used to ascertain the accuracy level of the bridge and as a base from which all other data collected at the same site could be compared. A portion of the remaining day was spent collecting "normal" truck data in an attempt to

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determine whether a decrease in the overall amount of truck traffic could be found one day after enforcement was present at the site. The coefficient of variation measurements from all three enforcement sites are contained in Table J. These results have been further separated into vehicles less than and greater than 40,000 pounds.

TABLE J

COEFFICIENTS OF VARIATION FOR ENFORCEMENT SITES

	PORTAGE	MONICO	BANGOR	ALL SITES
STEERING	17.8	18.5	18.2	21.1
DRIVE	15.4	10.9	16.8	17.3
TRAILER	18.7	28.3	23.7	31.9
GROSS	9.0	12.9	17.3	18.7
		<40,000 POUNDS		
STEERING	23.1	17.4	18.1	23.6
DRIVE	21.1	32.6	18.5	25.2
TRAILER	14.4	18.3	23.5	23.5
GROSS	8.1	16.4	12.7	14.4
		>40,000 POUNDS		
STEERING	13.5	18.8	18.2	20.0
DRIVE	12.7	6.8	13.7	14.5
TRAILER	17.5	24.8	18.2	29.8
GROSS	8.5	9.4	13.2	17.1

At Portage, a total of 548 trucks were weighed and recorded using the BWIM equipment with nearly one-half of that figure in excess of 40,000 pounds. The ±8.5% coefficient of variation (C.V.) for vehicles >40,000# at Portage was then applied to the 80,000 pound maximum weight limit which subsequently allowed for a range of error beginning at slightly less than 74,000#. During the first two days of "normal" data collection, 19% of the vehicles weighed were in excess of 74,000#. The following day, "abnormal" data collection activities were held in conjunciton with portable scale operations. Less than 5% of all vehicles were found in the greater than 74,000# range. On the next day, no vehicles were collected which were greater than 74,000#. It is obvious that the presence of enforcement personnel has caused these percentages to rapidly diminish. Even one day after the lodec operation was conducted, truck drivers with heavy loads were avoiding this location. On "normal" days, nearly 20% of the loaded truck traffic has the potential of being overweight.

The bridge location at Monico presented an entirely new set of conditions. All traffic travelling south on USH 45 had to stop at the junction with USH 8, east of Monico. To continue south on USH 45, traffic must proceed west on USH 8-45 for one-half of a mile to the second north/south junction with USH 45. After turning west, speeds of various trucks were hampered by the short distance before a steep incline to the bridge. Minus weights and error messages were recorded on some trucks travelling less than 25 m.p.h. at the time they crossed the bridge. Weights of vehicles travelling west on USH 8 were unaffected by the elevated approach, however. In all, 170 trucks were recorded at Monico with slightly less than 50% weighing in excess of 40,000#. Of those vehicles considered loaded throughout the

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week, 55% had the potential of being overweight and at least 26% were known to be overweight during lodec operation. Again, potential figures are based on the ±9.4% gross weight C.V. on loaded vehicles at Monico. These results help to explain the overweight truck problem which is currently taking place even in some of the most remote areas of the state. Several drivers were not aware of the fact that the DSP operates portable scales on select low volume highways and many expressed the opinion it is well worth the gamble to run overweight.

The I-94 location near Bangor provided us with our first attempt at using a short span bridge with no skew angle(0°). This portion of the interstate carriers a high volume of truck traffic travelling eastward from points in western states as well as industries located in La Crosse. Because much of the traffic is from outside the state, the term "port of entry" has been used to describe the type of activity taking place. The bridge itself had recently been reconditioned and resurfaced and appeared to be a perfect candidate for BWIM use. However individual results collected at this site were found to be some of the least accurate of the three enforcement locations. BWIM weights were consistently much lower on the heavier or loaded carriers and little, if any, reasoning could be utilized to resolve the problem. Several more truck samples (789) were collected at this test site compared to any of the others but unfortunately the final tabulation also proved less than satisfactory. The gross weight C.V. of ±13.2% on vehicles weighing over 40,000 pounds provided a considerable range of error. Of the total number of loaded vehicles, only 3% fell within the ±13.2% range and those were on the minus side. Further analysis indicated that nearly every vehicle was underweighed by several thousand pounds. One possible explanation as to the major discrepancies in value may originate in the fact that as a vehicle approached the bridge, a slight incline was noticed at a distance within 30 feet to the front edge of the bridge. According to BWIM specifications, however, this circumstance should have little effect on the results.

Overview

The majority of our analysis has shown the existence of a moderate percentage of potential overweight vehicles with some situations having a comparatively high concentration. However, without reducing the current range of error, pinpointing individual overweight trucks becomes very difficult. For example, if the BWIM records an 82,000 pound semi and the C.V. is ±10%, the officer does not have probable cause because the 82,000 pound weight may actually be lower. The real weight of the truck could range anywhere from 73,800 to 90,200 pounds. When the BWIM is installed on known seasonal overload routes where gross weights of 90,000 plus pounds can be expected, a BWIM reading of 92,000 pounds gross weight certainly supports the case for probable cause. The actual weight is most likely between 82,800 and 101,200 pounds. In this case any gross load over 89,000# would be a likely overweight candidate.

The DSP is also understandably concerned about the BWIM data which has been collected the past two years for the Truck Weight Study(TWS). This information could be very useful, especially as it pertains to overweight trucks and future enforcement planning. The basic question surrounding the TWS data which has been collected at 19 separate locations is; What is the statistical reliability and validity of the TWS data and what statements, if any, can be made about the frequency, weights and types of overweight trucks? Again, without knowing the accuracy level for each individual bridge site, definite answers are unavailable. If the averaged coefficient of variation is used for all test samples, a

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generalized mid-range C.V. is developed which can serve as the standard accuracy level for all sites. To many people's surprise, our tests have proven that the individual characteristics of each bridge play an important role in the level of accuracy one can expect. However, our tests did not provide a direct correlation between a most preferred bridge configuration and improved accuracy results. If program modifications and other technological advances can be made by the manufacturer in the near future, improvements in the results are entirely possible. Without these changes, however, serious limitations and/or restrictions would be placed upon enforcements involvement with this system, especially as they concern the usefulness associated with the data which has and will soon be collected.

SUMMARY

Because the dynamic effects are prevalent with vehicles travelling at highway speeds, the BWIM system lacks the necessary weighing tolerance for sharply defined enforcement weighings. On what were perceived to be generally smooth roadway surfaces, errors of up to ±25% on any given individual axle could be expected. If the roughness of the roadway became significantly greater, the WIM measured dynamic forces and the actual weights could reach differences in excess of ±50%. The variance between dynamic and static weights was not limited to single axles versus tandem axles or multiple sets of axles. The errors were basically a result of the rapid movement of the vehicle and its interaction with the suspension and the type of load it was carrying. As demonstrated throughout this analysis, errors in axle weights which are caused by dynamic forces appear to be randomly distributed. Consequently, plus and minus errors tend to balance or cancel each other out when calculating mean weights of a large sample size, such that the mean WIM gross weight is usually off by less than 1000 pounds from the mean static gross weight. Average individual axle weights for all vehicles also usually approach a more moderate figure compared to any one individual weight.

One aspect of the system which may pertain more to specific data user needs of the TWS information is the fact that it does not allow for the driver interview section of the study. Particular factual material found throughout portions of the TWS questionnaire such as permit status, trip routing, registered weight and origin/destinations is not retrievable with WIM. These types of driver characteristics would still have to be collected using the original survey format at designated weigh stations. Several other specific advantages and limitations of the BWIM system follow.

Main advantages of the BWIM System are:

* The weighing device including the set of strain gauges is invisible to the motorist and the entire system is unobtrusive for the most part;

* The system can be moved from girdered bridge to girdered bridge without difficulty making it one of the most portable operations on the market;

* Depending upon the location selected for data collection, essentially no site construction is required to install the system;

* The system requires only two people to operate and classify, and only one person is necessary for monitoring the apparatus in its automatic mode capacity;

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* By pressing the correct commodity description into the key pad, a listing of all the vehicle transport types recorded at any given station location is made available.

* The system provides a great deal of flexibility, both from the standpoint of increasing highway system coverage throughout a large geographic distribution as well as increasing efficiency in the rate of collecting data in comparison to previous methods.

Primary limitations of the BWIM System are:

* The system can only be used on concrete and steel girdered bridges, rendering several other bridge configurations in Wisconsin inadequte for its use;

* The bridge girders underneath the structure must be accessible to the crew members measuring and setting the strain gauges;

* When two or more trucks are travelling on the bridge at one time the system is not able to properly record any of the vehicle's weights;

* The system must be properly calibrated for each bridge which requires obtaining a measured weight calibration truck and compensation for its use;

* The system's electronic components must be located very near the bridge which creates concern when selecting a site both suitable and unobtrusive for the van;

* Unless speeds of vehicles can be slowed and approach pavements smoothed, problems of individual axle as well as gross weight inaccuracies will continue;

* Individual axle errors are randomly distributed on heavier loads, resulting in data which is acceptable for many planning purposes such as computing average loads of a specific station location or highway system category but is not accurate enough for the enforcement of truck weight laws.

In the past, Truck Weight Study data and information was compiled at specified locations throughout the state, leaving serious questions and concerns as to its validity in representing all vehicular travel patterns and occurrences. Furthermore, a considerable amount of time and manpower was required to organize and conduct various activities relative to the study's operational procedures. The outcome or final tabulation was nevertheless as accurate as could be expected. Because of its portability, the BWIM now allows for the collection of truck samples which are entirely representative of any given area of the state for a portion of the original overall cost. However, as proven in this report, the accuracy level associated with those same truck weight samples at any given location can only be a collective estimate based upon all random test samples.

In theory and in practicality, the emerging BWIM System offers the possibility of significant improvements in the quality and cost effectiveness of truck weight data collected. As alluded to throughout the contents of this study, however, the system will not entirely replace the use of static scales and driver interviews for the collection of exact TWS planning data.

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APPENDIX I

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PROGRAM CYCLES AND ANNUAL COSTS[1]
OF WISDOT'S TRUCK WEIGHT STUDY

	FY83	FY84	FY85	FY86	FY87	FY88	FY83-88
New Truck Weight Study With WIM	Start-Up: Training, Site Selection	Weight Survey at 10 Stations	Weight Survey at 11 Stations	Weight Survey at 10 Stations	Weight Survey at 11 Stations	Total Survey at 6 Stations*	
In-House Costs	$10,000	$20,000	$29,500	$28,800	$34,000	$10,800	$133,100
LTE Costs	0	0	0	0	0	24,800	24,800
Bridge WIM[2]	16,120	16,120	16,120	16,120	16,120	0	80,600
	$26,120	$36,120	$45,620	$44,920	$50,120	$35,600	$238,500
Previous Truck Weight Study With Loadometers	Total Survey at 11 Stations	Vehicle Classification at 11 Stations	Total Survey at 11 Stations	Vehicle Classification at 11 Stations	Total Survey at 11 Stations	Vehicle Classification at 11 Stations	
In-House Costs	$15,200	$16,350	$17,600	$18,900	$20,300	$21,800	$110,200
LTE Costs	34,600	0	40,000	0	46,200	0	120,800
	$49,800	$16,350	$57,600	$18,900	$66,500	$21,800	$231,000

[1] 7.5% annual inflation. In-House and LTE costs include salary, fringe, and travel.

[2] 1983 Bridge WIM system purchase cost of $80,600 amortized over 5 years, excluding van.

*At Loadometer Weigh Stations.

NOTES:

Total Survey = collection of weight/classification and driver-interview data.
Weight Survey = collection of weight/classification data.
Vehicle Classification = collection of 24 hour vehicle classification data on traffic stream at weight stations.

APPENDIX II

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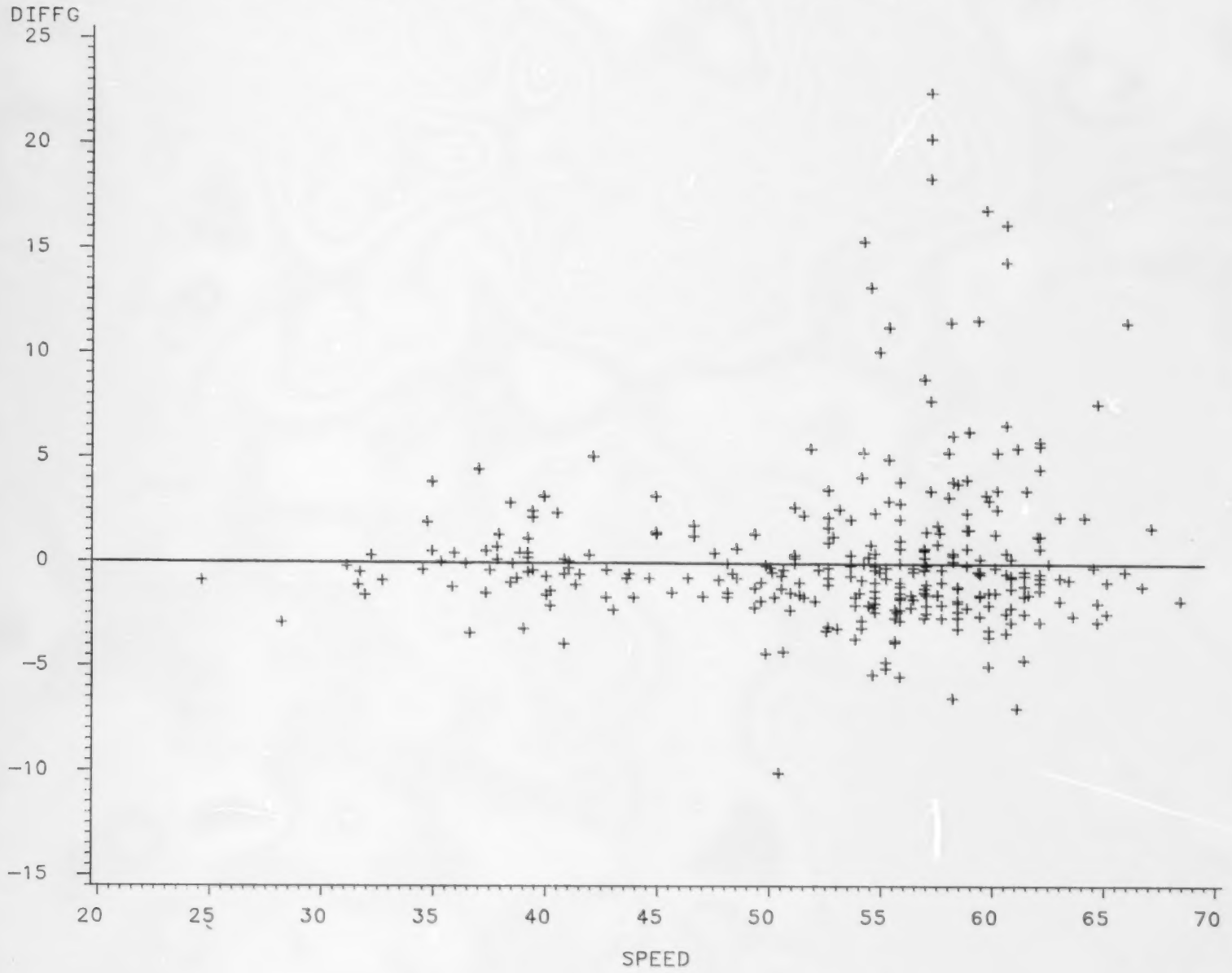
GROSS WEIGHT ABSOLUTE ERRORS VERSUS SPEED



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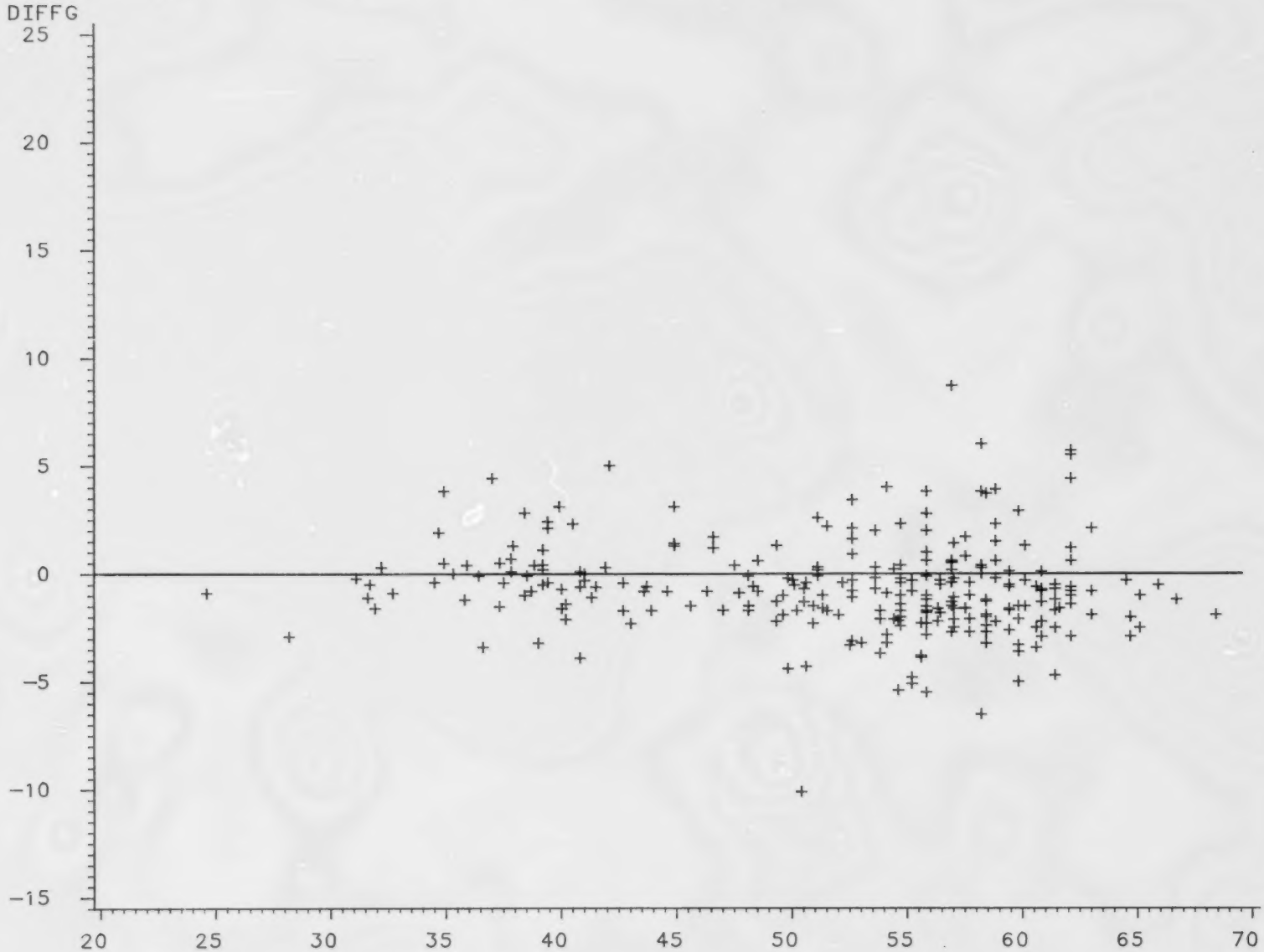
GROSS WEIGHT ABSOLUTE ERRORS VERSUS SPEED



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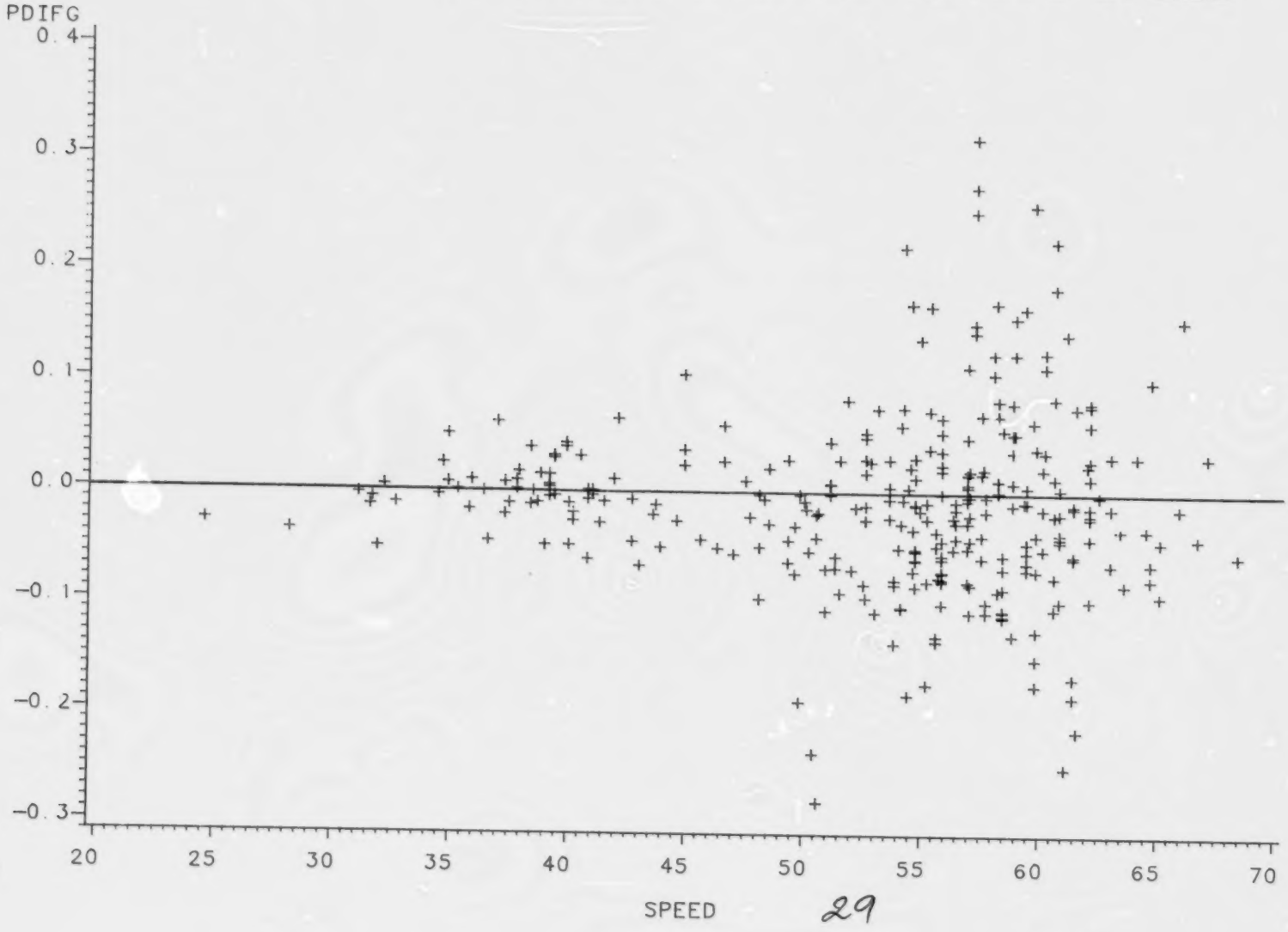
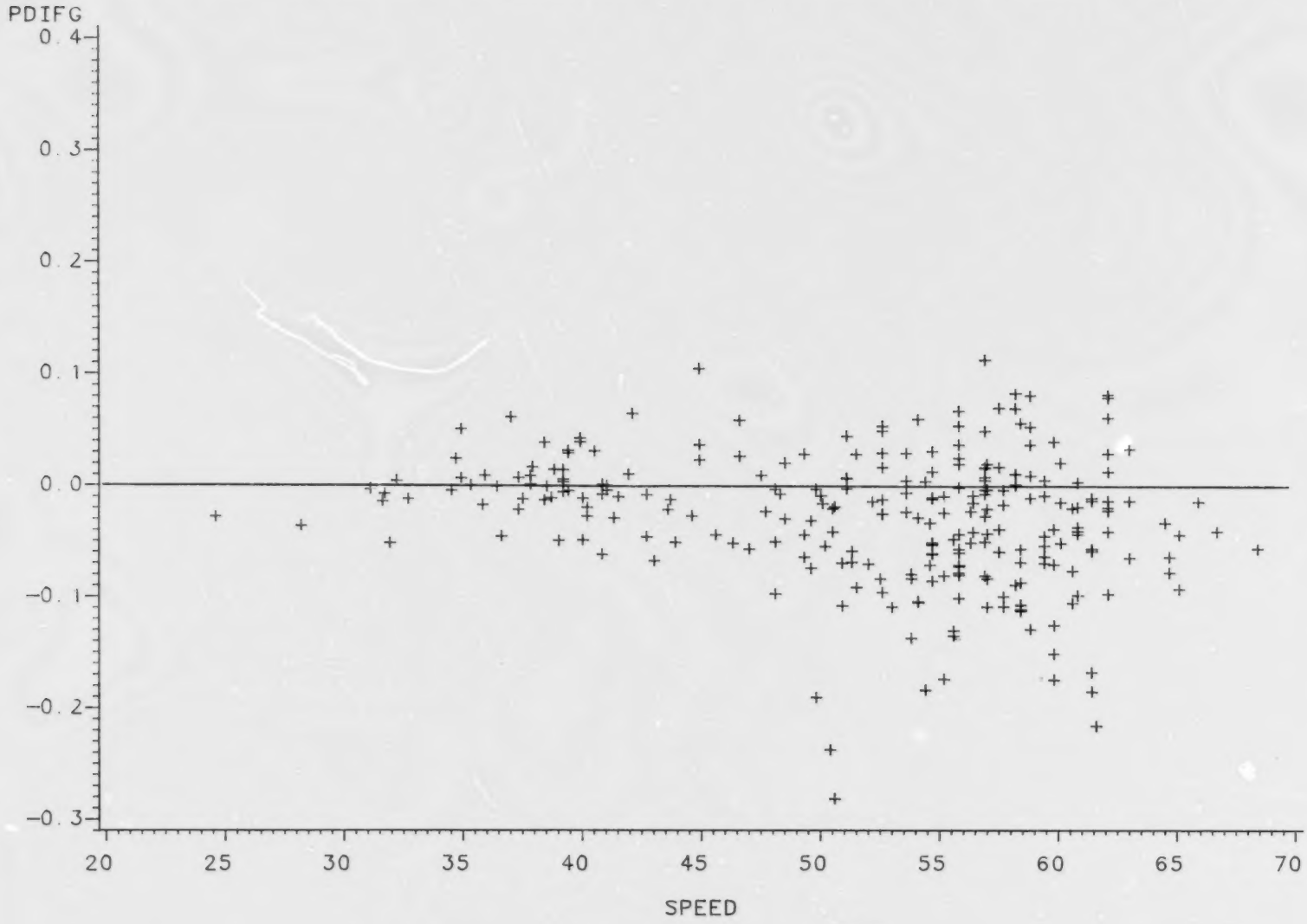
GROSS WEIGHT PERCENT ERRORS VERSUS SPEED



GROSS WEIGHT PERCENT ERRORS VERSUS SPEED



EXCLUDING UTICA SITE

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APPENDIX III

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ONE-TO-ONE COMPARISONS
STATIC SCALE AND BRIDGE WIM TRUCK WEIGHTS

OBS	TRKTYPE	SSWGT	WSWGT	SDWGT	WDWGT	STWGT	WTWGT	SGWGT	WGWGT	SITE	DIFFG	PDIFG
1	3S2	11.3	12.3	34.2	31.6	30.8	31.8	76.3	75.7	LAX	-0.6	-0.008
2	2S2	8.8	12.1	9.4	3.7	8.8	7.6	27.0	23.4	LAX	-3.6	-0.133
3	3S2	10.0	14.8	33.6	29.6	32.4	35.0	75.1	79.5	LAX	4.4	0.059
4	3S2	9.7	9.0	17.5	18.2	18.3	17.4	45.5	44.7	LAX	-0.8	-0.018
5	3S2	9.7	8.4	14.0	14.2	8.0	7.4	32.7	30.2	LAX	-2.5	-0.076
6	3S2	7.8	8.5	13.1	15.2	8.8	7.8	29.7	31.4	LAX	1.7	0.057
7	3S2	9.8	10.2	14.7	11.0	12.5	10.8	37.0	32.1	LAX	-4.9	-0.132
8	3S2	10.0	12.3	31.4	28.4	32.1	34.0	73.5	74.8	LAX	1.3	0.018
9	2S2	6.9	12.5	13.4	9.0	13.3	13.0	33.5	34.6	LAX	1.1	0.033
10	3S2	9.0	11.2	31.2	28.6	28.9	30.8	69.1	70.7	LAX	1.6	0.023
11	3S2	10.0	10.9	32.5	30.0	30.7	32.0	73.3	72.9	LAX	-0.4	-0.005
12	3S2	9.7	11.0	31.9	30.8	31.6	35.4	73.2	77.3	LAX	4.1	0.056
13	3S2	8.7	12.2	14.4	9.8	10.1	10.0	33.2	32.1	LAX	-1.1	-0.033
14	3S2	8.2	9.8	13.3	10.2	9.6	9.6	31.1	29.6	LAX	-1.5	-0.048
15	3S2	8.2	11.3	21.9	17.4	17.1	17.4	47.2	46.1	LAX	-1.1	-0.023
16	3S2	9.0	10.4	33.4	34.0	31.9	35.4	74.3	79.9	LAX	5.6	0.075
17	3S2	9.4	11.4	32.9	31.2	33.7	36.2	76.0	78.7	LAX	2.7	0.036
18	3S2	11.3	12.8	33.7	30.8	33.8	35.8	78.7	79.5	LAX	0.8	0.010
19	3S2	11.4	10.2	33.4	32.8	31.8	31.6	76.5	74.5	LAX	-2.0	-0.026
20	3S2	11.3	14.2	32.6	29.2	31.4	33.6	75.2	76.8	LAX	1.6	0.021
21	2SG	5.6	8.7	8.9	5.1	.	.	14.5	13.8	LAX	-0.7	-0.048
22	2S2	10.0	8.4	12.2	13.0	13.5	12.8	35.7	34.3	LAX	-1.4	-0.039
23	3S2	9.9	10.3	30.9	30.8	31.9	35.8	72.7	76.9	LAX	4.2	0.058
24	3S2	9.6	9.2	27.2	25.0	22.7	23.0	59.5	57.2	LAX	-2.3	-0.039
25	3S2	9.0	9.9	14.2	11.6	9.0	9.2	32.2	30.8	LAX	-1.4	-0.043
26	3S2	7.4	10.1	12.8	10.0	9.1	8.2	29.3	28.3	LAX	-1.0	-0.034
27	3S2	9.5	10.2	33.8	32.6	32.8	33.4	76.1	76.2	LAX	0.1	0.001
28	3S2	9.0	9.3	12.8	10.2	8.2	7.8	30.0	27.2	LAX	-2.8	-0.093
29	3S2	11.2	12.7	31.8	28.6	34.6	36.4	77.5	77.6	LAX	0.1	0.001
30	3S2	10.1	10.1	32.6	31.2	29.7	31.0	72.4	72.4	LAX	0.0	0.000
31	3S2	10.5	10.2	30.7	32.2	31.8	33.8	73.0	76.2	LAX	3.2	0.044
32	3S2	8.5	13.0	24.3	20.6	13.1	15.6	45.9	49.3	LAX	3.4	0.074
33	3S2	11.1	10.3	33.5	33.6	33.0	34.8	77.6	78.7	LAX	1.1	0.014
34	3S2	11.8	12.5	33.5	31.4	33.3	34.8	78.5	78.6	LAX	0.1	0.001
35	3S2	9.1	10.1	16.9	14.0	11.7	12.2	37.8	36.3	LAX	-1.5	-0.040
36	3S2	11.0	8.4	33.7	33.2	31.7	32.8	76.4	74.5	LAX	-1.9	-0.025
37	3S2	9.5	6.9	32.4	32.0	28.8	30.8	70.8	69.6	LAX	-1.2	-0.017
38	3S2	9.3	6.5	15.2	15.2	9.5	10.0	34.0	31.7	LAX	-2.3	-0.068
39	3S2	10.4	9.2	33.2	32.8	32.3	34.6	75.8	76.6	LAX	0.8	0.011
40	2S1	8.5	6.8	9.3	9.8	7.3	7.8	25.2	24.4	LAX	-0.8	-0.032
41	3S2	8.5	7.2	13.4	13.4	8.3	9.6	30.1	30.1	LAX	0.0	0.000
42	3S2	8.9	9.3	28.2	25.6	27.0	27.0	64.0	61.8	LAX	-2.2	-0.034
43	3S2	11.9	10.9	33.6	32.8	33.4	35.6	78.9	79.3	LAX	0.4	0.005
44	3S2	11.5	9.5	33.3	32.6	34.4	37.0	79.2	79.2	LAX	0.0	0.000
45	3S2	10.7	8.8	32.2	31.2	28.2	29.6	71.0	69.6	LAX	-1.4	-0.020
46	3S2	10.0	9.6	32.1	31.0	33.1	35.2	75.2	75.7	LAX	0.5	0.007
47	3S2	10.8	7.9	33.4	34.4	32.1	34.6	76.3	76.9	LAX	0.6	0.008
48	3S2	10.6	10.3	26.2	23.0	26.1	25.2	62.8	58.4	LAX	-4.4	-0.070
49	3S2	9.0	7.3	12.8	12.2	7.9	8.8	29.8	28.3	LAX	-1.5	-0.050
50	2SG	3.1	2.1	4.3	3.9	.	.	7.4	6.0	LAX	-1.4	-0.189
51	3S2	9.5	8.7	24.9	25.0	21.9	24.4	56.3	58.1	LAX	1.8	0.032
52	3S2	9.0	10.1	33.5	30.0	31.1	33.2	73.6	73.3	LAX	-0.3	-0.004
53	3S2	9.4	9.8	28.3	25.6	27.9	29.6	65.5	65.0	LAX	-0.5	-0.008
54	3S2	7.9	5.1	10.7	12.2	7.6	8.4	26.3	25.6	LAX	-0.7	-0.027
55	3SG	9.1	8.8	8.5	7.2	.	.	17.6	15.9	LAX	-1.7	-0.097

ONE-TO-ONE COMPARISONS
STATIC SCALE AND BRIDGE WIM TRUCK WEIGHTS

OBS	TRKTYPE	SSWGT	WSWGT	SDWGT	WDWGT	STWGT	WTWGT	SGWGT	WGWGT	SITE	DIFFG	PDIFG
56	4CB	6.7	4.5	12.9	14.3	9.3	10.6	28.9	29.3	LAX	0.4	0.014
57	3S2	11.0	8.3	33.1	34.2	33.5	36.6	77.6	79.1	LAX	1.5	0.019
58	3S2	8.3	7.3	10.2	9.2	7.0	7.2	25.5	23.5	LAX	-2.0	-0.078
59	3S2	10.4	9.8	30.2	28.2	28.2	29.2	68.8	67.1	LAX	-1.7	-0.025
60	3S2	10.2	9.2	33.1	32.4	31.9	33.2	75.3	74.9	LAX	-0.4	-0.005
61	3S2	9.6	6.7	16.2	17.0	12.4	13.4	38.2	37.2	LAX	-1.0	-0.026
62	4CB	8.3	6.8	8.8	8.7	9.8	10.0	26.9	25.5	LAX	-1.4	-0.052
63	3S2	11.7	9.6	33.9	31.2	33.9	35.6	79.5	76.4	LAX	-3.1	-0.039
64	3S2	10.1	8.5	31.7	31.0	32.3	33.6	74.1	73.2	LAX	-0.9	-0.012
65	3S2	9.4	6.6	12.2	13.8	8.1	9.8	29.8	30.2	LAX	0.4	0.013
66	3S2	8.9	9.9	12.5	10.0	7.4	8.4	28.8	28.2	LAX	-0.6	-0.021
67	3S2	8.6	7.7	13.8	12.6	9.4	10.6	31.8	30.9	LAX	-0.9	-0.028
68	3S2	9.7	10.1	33.7	30.2	33.0	34.4	76.4	74.5	LAX	-1.9	-0.025
69	3S2	8.1	8.0	12.5	11.8	9.5	11.2	30.1	31.0	LAX	0.9	0.030
70	2SG	6.5	5.9	8.9	8.7	.	.	15.4	14.6	LAX	-0.8	-0.052
71	2SG	6.9	6.5	7.0	5.8	.	.	13.9	12.3	LAX	-1.6	-0.115
72	3S2	8.8	7.5	13.0	13.8	9.5	9.6	31.3	31.0	LAX	-0.3	-0.010
73	3S2	9.4	7.6	32.9	32.4	30.5	32.6	72.8	72.6	LAX	-0.2	-0.003
74	3S2	8.7	6.9	12.5	12.2	8.4	8.8	29.5	28.0	LAX	-1.5	-0.051
75	3S2	11.4	10.4	32.5	31.2	33.7	35.2	77.5	76.8	LAX	-0.7	-0.009
76	3S2	8.6	10.0	32.2	28.6	28.9	31.6	69.7	70.2	LAX	0.5	0.007
77	3S2	8.8	7.7	14.1	12.8	10.9	11.0	33.8	31.4	LAX	-2.4	-0.071
78	3S2	9.1	6.5	19.0	19.8	16.4	17.8	44.5	44.1	LAX	-0.4	-0.009
79	3S2	8.0	5.4	17.8	18.2	12.5	13.8	38.2	37.4	LAX	-0.8	-0.021
80	3S2	10.2	8.5	11.5	11.0	9.1	9.8	30.8	29.3	LAX	-1.5	-0.049
81	3S2	9.2	8.7	32.8	30.0	31.6	31.8	73.6	70.4	LAX	-3.2	-0.043
82	3S2	7.5	8.4	12.9	10.0	12.0	12.6	32.4	31.0	LAX	-1.4	-0.043
83	3S2	9.4	8.5	13.0	12.2	8.7	9.0	31.0	29.7	LAX	-1.3	-0.042
84	3S2	8.4	4.9	13.2	14.8	9.5	10.6	31.1	30.3	LAX	-0.8	-0.026
85	3S2	9.0	10.2	34.4	32.2	28.7	31.6	72.1	73.9	LAX	1.8	0.025
86	3S2	9.4	7.8	14.6	14.0	9.6	10.2	33.6	32.1	LAX	-1.5	-0.045
87	3S2	9.0	7.6	32.8	32.8	31.5	33.4	73.3	73.7	LAX	0.4	0.005
88	3S2	7.5	5.1	13.5	14.8	11.7	12.6	32.7	32.5	LAX	-0.2	-0.006
89	3S2	9.7	8.2	34.7	34.4	33.9	36.8	78.3	79.4	LAX	1.1	0.014
90	2SG	8.6	12.0	16.4	12.9	.	.	25.0	24.9	MNC	-0.1	-0.004
91	3S2	8.6	14.0	13.2	9.6	10.1	8.0	31.8	31.6	MNC	-0.2	-0.006
92	3S2	10.9	9.5	32.0	35.0	32.6	33.4	75.5	77.9	MNC	2.4	0.032
93	3SG	11.8	12.9	20.1	18.2	.	.	31.6	31.0	MNC	-0.6	-0.019
94	3S2	9.3	9.3	22.9	22.4	18.7	19.8	50.8	51.5	MNC	0.7	0.014
95	3S2	9.3	11.5	27.9	26.8	21.5	23.0	58.7	61.5	MNC	2.8	0.048
96	4CB	7.2	11.3	14.3	12.4	11.9	10.6	33.5	34.4	MNC	0.9	0.027
97	3S2	7.9	8.8	16.9	16.0	13.6	14.2	38.4	39.0	MNC	0.6	0.016
98	2SG	3.8	7.6	8.6	5.6	.	.	12.4	13.1	MNC	0.7	0.056
99	4CB	8.8	7.8	10.1	11.2	10.1	9.2	29.1	28.2	MNC	-0.9	-0.031
100	4CB	7.1	9.1	14.1	13.3	17.0	16.0	38.2	38.5	MNC	0.3	0.008
101	3SG	9.1	5.6	8.0	9.4	.	.	17.1	15.0	MNC	-2.1	-0.123
102	3S2	11.1	10.4	32.2	38.6	30.1	30.4	73.3	79.3	MNC	6.0	0.082
103	3S2	8.1	12.1	21.9	15.8	20.1	21.2	49.9	49.1	MNC	-0.8	-0.016
104	3S2	9.4	8.9	18.6	17.8	15.3	16.8	43.3	43.7	MNC	0.4	0.009
105	3CB	6.5	7.7	14.6	15.0	8.1	5.9	29.2	28.6	MNC	-0.6	-0.021
106	3S2	10.0	9.9	29.2	25.0	28.5	33.4	67.7	68.2	MNC	0.5	0.007
107	3S2	9.4	12.0	22.8	17.0	23.7	28.0	55.9	57.1	MNC	1.2	0.021
108	3S2	10.3	8.8	21.6	21.2	11.2	11.6	43.1	41.7	MNC	-1.4	-0.032
109	3CB	6.4	9.6	13.0	11.7	8.6	5.2	28.0	26.5	MNC	-1.5	-0.054
110	4CB	7.7	11.0	9.3	6.3	8.9	6.8	26.7	24.1	MNC	-2.6	-0.097

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ONE-TO-ONE COMPARISONS
STATIC SCALE AND BRIDGE WIM TRUCK WEIGHTS

OBS	TRKTYPE	SSWGT	WSWGT	SDWGT	WDWGT	STWGT	WTWGT	SGWGT	WGWGT	SITE	DIFFG	PDIFG
111	3S2	8.1	9.2	20.7	15.4	21.3	25.4	50.1	49.9	MNC	-0.2	-0.004
112	3S2	8.7	10.3	12.3	10.8	9.7	9.0	30.8	30.2	MNC	-0.6	-0.019
113	3S2	8.7	11.6	11.9	9.6	9.4	8.6	30.0	29.7	MNC	-0.3	-0.010
114	2SG	8.1	11.1	12.7	8.8	.	.	20.8	19.9	MNC	-0.9	-0.043
115	3S2	10.6	12.3	32.2	32.6	32.9	31.4	75.6	76.3	MNC	0.7	0.009
116	4CB	8.7	10.3	18.6	19.9	13.6	11.8	40.9	42.0	MNC	1.1	0.027
117	3S2	8.0	7.9	18.6	18.8	12.2	13.2	38.9	39.9	MNC	1.0	0.026
118	3S2	9.3	9.2	18.8	20.0	20.4	20.0	48.6	49.2	MNC	0.6	0.012
119	2SG	10.0	13.4	12.0	7.4	.	.	22.0	20.8	MNC	-1.2	-0.055
120	4CB	7.6	8.9	14.4	13.9	14.4	13.6	36.5	36.4	MNC	-0.1	-0.003
121	3S2	9.7	8.3	19.0	17.0	15.1	15.8	43.8	41.2	MNC	-2.6	-0.059
122	3SG	8.2	4.7	7.1	6.0	.	.	15.3	10.7	MNC	-4.6	-0.301
123	3S2	9.2	8.7	24.3	25.6	11.6	10.6	45.0	45.0	MNC	0.0	0.000
124	3S2	10.9	10.7	32.6	35.2	34.3	40.6	77.8	86.5	MNC	8.7	0.112
125	3SG	9.6	9.3	14.1	13.0	.	.	23.7	22.2	MNC	-1.5	-0.063
126	4CB	6.1	9.2	9.0	6.1	8.8	8.6	24.0	23.8	MNC	-0.2	-0.008
127	2SG	9.7	12.9	15.0	13.4	.	.	24.6	26.3	MNC	1.7	0.069
128	3S2	8.5	10.9	22.9	18.8	19.0	18.6	50.3	48.4	MNC	-1.9	-0.038
129	3S2	9.3	10.2	32.0	31.8	30.2	32.0	71.6	74.0	MNC	2.4	0.034
130	3S2	9.5	10.7	25.3	25.8	11.5	10.8	46.3	47.2	MNC	0.9	0.019
131	3SG	9.4	8.9	23.0	24.0	.	.	32.4	32.9	MNC	0.5	0.015
132	3CB	9.8	8.4	14.2	20.1	10.7	5.7	34.7	34.2	MNC	-0.5	-0.014
133	3S2	9.0	9.8	12.0	9.6	8.3	7.0	29.2	26.2	MNC	-3.0	-0.103
134	3S2	9.7	10.4	30.4	32.6	33.2	36.8	73.4	79.6	MNC	6.2	0.084
135	3S2	11.6	14.9	31.0	31.0	32.9	32.8	75.6	78.6	MNC	3.0	0.040
136	3S2	8.1	9.1	16.1	16.2	13.6	13.2	37.8	38.6	MNC	0.8	0.021
137	3S2	10.5	10.1	27.7	22.0	31.7	40.2	69.9	72.4	MNC	2.5	0.036
138	3S2	10.3	10.3	31.9	26.8	31.0	29.6	73.2	66.7	MNC	-6.5	-0.089
139	3S2	9.1	8.3	11.2	10.6	8.8	8.2	29.1	27.1	MNC	-2.0	-0.069
140	3S2	9.2	8.4	19.4	19.4	13.3	16.0	41.9	43.7	MNC	1.8	0.043
141	3S2	11.0	10.6	33.3	37.0	31.0	31.6	75.3	79.2	MNC	3.9	0.052
142	3SG	10.1	14.7	33.6	29.2	.	.	43.7	44.0	MNC	0.3	0.007
143	3S2	8.6	11.4	17.7	12.6	13.2	11.8	39.4	35.7	MNC	-3.7	-0.094
144	3S2	8.7	7.8	12.9	10.6	7.7	5.8	29.3	24.2	MNC	-5.1	-0.174
145	3S2	9.5	11.8	29.5	23.8	29.3	27.2	68.3	62.8	MNC	-5.5	-0.081
146	3S2	6.5	11.7	29.3	25.6	26.9	23.2	62.7	60.5	MNC	-2.2	-0.035
147	3S2	9.4	7.7	12.4	11.4	9.0	8.0	30.8	27.0	MNC	-3.8	-0.123
148	3S2	7.2	10.2	12.8	7.2	9.4	8.0	29.4	25.6	MNC	-3.8	-0.129
149	3S2	8.8	9.2	21.8	21.6	19.1	19.8	49.8	50.7	MNC	0.9	0.018
150	3S2	8.6	12.4	15.7	13.0	13.3	10.2	37.7	35.7	MNC	-2.0	-0.053
151	3S2	10.5	8.4	12.9	13.4	10.1	9.2	33.5	31.0	MNC	-2.5	-0.075
152	3S2	7.9	7.1	11.1	10.4	8.7	7.6	27.7	25.2	MNC	-2.5	-0.090
153	3S2	10.1	11.4	31.0	25.2	34.3	33.4	75.4	69.9	MNC	-5.5	-0.073
154	3S2	8.1	10.1	12.3	11.6	8.5	10.0	28.9	31.6	MNC	2.7	0.093
155	2SG	3.6	5.8	5.0	2.1	.	.	8.6	8.0	MNC	-0.6	-0.070
156	3S2	10.4	8.3	10.6	12.0	8.4	7.6	29.3	27.9	MNC	-1.4	-0.048
157	4CB	10.1	13.0	9.2	6.2	7.1	6.0	26.3	25.1	MNC	-1.2	-0.046
158	2SG	7.3	9.7	10.0	7.4	.	.	17.3	17.1	MNC	-0.2	-0.012
159	3S2	9.1	10.3	10.6	8.0	7.1	5.5	26.8	23.9	MNC	-2.9	-0.108
160	3S2	8.7	9.7	11.8	10.2	8.3	7.6	28.9	27.5	MNC	-1.4	-0.048
161	3S2	9.0	8.9	11.2	10.8	6.5	6.0	26.8	25.7	MNC	-1.1	-0.041
162	3S2	9.5	9.0	18.4	18.0	18.7	18.4	46.6	45.5	MNC	-1.1	-0.024
163	3S2	8.7	8.6	19.8	19.6	12.1	11.2	40.5	39.3	MNC	-1.2	-0.030
164	2SG	11.2	15.8	11.5	6.0	.	.	22.7	21.8	MNC	-0.9	-0.040
165	3S2	11.0	15.0	33.5	33.0	30.7	28.0	75.2	76.0	MNC	0.8	0.011

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STATIC SCALE AND BRIDGE WIM TRUCK WEIGHTS

OBS	TRKTYPE	SSWGT	WSWGT	SDWGT	WDWGT	STWGT	WTWGT	SGWGT	WGWGT	SITE	DIFFG	PDIFG
166	2SG	3.4	4.9	3.1	0.4	.	.	6.5	5.4	MNC	-1.1	-0.169
167	3S2	8.1	11.0	12.5	10.0	8.8	7.0	29.4	28.0	MNC	-1.4	-0.048
168	2SG	5.4	6.9	6.2	4.1	.	.	11.6	11.0	MNC	-0.6	-0.052
169	4CB	8.6	9.7	11.5	11.6	15.3	13.6	35.4	34.9	MNC	-0.5	-0.014
170	3S2	8.4	7.8	16.6	14.2	15.4	16.0	40.5	38.0	MNC	-2.5	-0.062
171	3S2	8.2	10.2	26.8	22.2	24.5	22.4	59.5	54.8	MNC	-4.7	-0.079
172	3S2	8.5	9.1	16.6	14.8	12.0	11.4	37.0	35.4	MNC	-1.6	-0.043
173	5OT	3.4	5.1	9.4	10.6	8.3	5.1	21.2	20.6	MNC	-0.6	-0.028
174	3S2	10.9	10.2	30.0	31.2	30.0	32.8	70.5	74.2	MNC	3.7	0.052
175	3S2	7.9	8.9	12.6	11.4	9.2	9.8	30.0	30.1	MNC	0.1	0.003
176	4CB	7.2	11.1	10.2	7.3	9.5	6.8	26.8	25.2	MNC	-1.6	-0.060
177	3S2	9.0	9.4	11.7	9.4	8.9	8.2	29.6	27.1	MNC	-2.5	-0.084
178	3S2	9.0	9.4	16.0	15.0	13.9	12.6	38.9	36.9	MNC	-2.0	-0.051
179	2SG	6.0	8.3	10.5	7.3	.	.	16.5	15.7	MNC	-0.8	-0.048
180	3S2	10.2	11.0	34.0	34.6	33.4	31.8	77.6	77.5	MNC	-0.1	-0.001
181	3S2	7.8	8.6	10.9	8.8	7.0	7.4	25.7	24.9	MNC	-0.8	-0.031
182	3S2	9.5	10.7	11.9	10.2	8.0	7.0	29.3	27.9	MNC	-1.4	-0.048
183	3S2	10.0	8.4	12.4	12.8	8.8	7.8	31.1	29.0	MNC	-2.1	-0.068
184	3S2	9.4	10.7	32.2	40.2	32.3	26.8	73.9	77.7	MNC	3.8	0.051
185	3SG	11.9	15.7	43.2	42.9	.	.	55.2	58.6	MNC	3.4	0.062
186	3S2	8.5	9.4	25.0	21.0	22.3	23.8	55.8	54.0	MNC	-1.8	-0.032
187	4CB	7.5	9.0	7.6	7.8	13.9	10.0	29.0	26.9	MNC	-2.1	-0.072
188	3S2	7.7	10.1	30.4	35.6	30.0	27.2	68.0	73.0	MNC	5.0	0.074
189	3S2	8.4	9.2	16.1	14.6	9.7	9.8	34.1	33.5	MNC	-0.6	-0.018
190	3S2	9.2	7.4	19.6	21.2	13.0	12.4	41.8	41.0	MNC	-0.8	-0.019
191	3S2	9.8	8.4	13.5	13.6	8.1	8.2	31.4	30.2	MNC	-1.2	-0.038
192	3S2	9.7	10.6	19.1	19.2	12.8	11.8	41.6	41.7	MNC	0.1	0.002
193	3S2	11.1	14.1	30.8	32.8	30.1	29.4	72.0	76.4	MNC	4.4	0.061
194	3S2	9.9	10.2	16.3	14.8	16.3	18.6	42.4	43.7	MNC	1.3	0.031
195	4CB	7.8	11.9	12.6	9.3	12.4	11.4	32.9	32.7	MNC	-0.2	-0.006
196	2SG	6.8	9.9	9.9	5.7	.	.	16.6	15.6	MNC	-1.0	-0.060
197	3S2	8.7	10.8	32.5	32.6	27.1	29.0	68.3	72.3	MNC	4.0	0.059
198	3S2	8.6	10.2	13.4	13.6	8.6	8.0	30.7	31.6	MNC	0.9	0.029
199	3S2	10.0	8.5	11.8	14.8	8.6	9.2	30.3	32.5	MNC	2.2	0.073
200	3S2	10.6	9.9	27.8	23.4	28.3	34.6	66.6	67.9	MNC	1.3	0.020
201	4CB	8.9	10.3	16.8	18.2	14.9	13.0	40.6	41.4	MNC	0.8	0.020
202	3S2	9.3	8.4	19.2	18.6	20.4	22.0	48.9	49.1	MNC	0.2	0.004
203	3S2	8.6	7.3	19.6	19.6	10.4	10.0	38.6	36.9	MNC	-1.7	-0.044
204	3S2	9.0	10.7	13.4	14.0	7.7	5.6	30.1	30.2	MNC	0.1	0.003
205	3S2	8.3	8.4	13.2	14.0	9.2	8.4	30.6	30.8	MNC	0.2	0.007
206	2SG	7.5	11.1	11.8	8.1	.	.	19.3	19.2	MNC	-0.1	-0.005
207	3S2	8.7	10.7	12.5	11.6	9.8	8.4	31.0	30.7	MNC	-0.3	-0.010
208	2SG	4.6	4.6	6.8	5.0	.	.	11.4	9.6	STP	-1.8	-0.158
209	2SG	8.9	7.9	12.3	11.5	.	.	21.2	19.3	STP	-1.9	-0.090
210	3S2	9.9	7.8	30.1	32.8	28.0	27.2	67.9	67.8	STP	-0.1	-0.001
211	3SG	7.2	6.9	13.5	11.2	.	.	20.6	18.2	STP	-2.4	-0.117
212	3S2	8.2	6.7	12.6	12.6	7.9	8.2	28.7	27.6	STP	-1.1	-0.038
213	2SG	7.5	6.9	10.9	10.2	.	.	18.5	17.1	STP	-1.4	-0.076
214	3S2	7.6	9.3	11.7	7.8	7.6	8.2	26.9	25.4	STP	-1.5	-0.056
215	2SG	3.7	5.3	5.3	3.3	.	.	8.9	8.6	STP	-0.3	-0.034
216	2SG	7.3	5.8	8.0	7.7	.	.	15.3	13.5	STP	-1.8	-0.118
217	3SG	7.5	5.4	15.5	14.2	.	.	23.0	19.5	STP	-3.5	-0.152
218	3S2	8.4	7.7	12.2	10.4	8.8	9.4	29.4	27.5	STP	-1.9	-0.065
219	3SG	13.8	12.9	30.5	28.0	.	.	44.3	41.0	STP	-3.3	-0.074
220	4CB	4.3	6.7	10.2	7.2	4.8	3.0	19.3	17.0	STP	-2.3	-0.119

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OBS	TRKTYPE	SSWGT	WSWGT	SDWGT	WDWGT	STWGT	WTWGT	SGWGT	WGWGT	SITE	DIFFG	PDIFG
221	3S2	7.4	8.0	10.9	7.0	7.9	9.0	26.2	23.9	STP	-2.3	-0.088
222	2SG	7.6	6.1	10.0	9.8	.	.	17.6	16.0	STP	-1.6	-0.091
223	3S2	9.2	10.5	15.5	12.8	9.8	10.4	34.5	33.7	STP	-0.8	-0.023
224	3S2	9.7	12.1	33.2	34.8	30.9	30.6	73.9	77.4	STP	3.5	0.047
225	3S2	9.9	8.2	14.0	12.6	8.4	9.0	32.3	29.8	STP	-2.5	-0.077
226	3S2	8.7	8.6	13.0	11.8	9.1	9.4	30.9	29.8	STP	-1.1	-0.036
227	3S2	8.1	7.8	11.8	11.4	7.2	5.8	27.1	25.0	STP	-2.1	-0.077
228	3S2	9.4	7.4	29.5	32.2	31.5	32.0	70.4	71.7	STP	1.3	0.018
229	3S2	10.2	8.0	23.2	23.6	23.4	25.0	56.8	56.6	STP	-0.2	-0.004
230	2SG	5.2	8.8	12.3	7.4	.	.	17.5	16.1	STP	-1.4	-0.080
231	3S2	8.4	8.8	22.9	23.4	22.2	22.0	53.5	54.3	STP	0.8	0.015
232	3S2	9.1	9.1	30.8	30.8	27.7	31.2	67.7	71.0	STP	3.3	0.049
233	3S2	8.7	10.0	11.9	4.8	7.4	8.4	28.0	23.3	STP	-4.7	-0.168
234	3S2	8.7	9.8	13.0	8.2	8.9	10.4	30.6	28.6	STP	-2.0	-0.065
235	2SG	6.0	4.7	6.3	6.4	.	.	12.2	11.2	STP	-1.0	-0.082
236	3S2	9.0	9.2	14.7	12.8	8.5	9.2	32.3	31.1	STP	-1.2	-0.037
237	3S2	11.1	10.5	27.8	26.2	27.3	32.6	66.2	69.3	STP	3.1	0.047
238	3S2	10.8	12.2	33.5	34.4	33.5	34.2	77.8	80.7	STP	2.9	0.037
239	3S2	8.7	11.3	11.6	7.2	9.0	10.0	29.4	28.4	STP	-1.0	-0.034
240	3S2	9.7	8.9	30.3	32.0	16.7	16.8	56.7	57.6	STP	0.9	0.016
241	3S2	9.8	8.3	21.2	19.6	11.4	11.0	42.4	38.7	STP	-3.7	-0.087
242	3S2	8.1	8.1	17.9	15.2	10.5	11.0	36.5	34.2	STP	-2.3	-0.063
243	2SG	8.9	7.9	10.3	9.7	.	.	19.2	17.6	STP	-1.6	-0.083
244	4CB	8.8	7.4	14.8	14.0	4.5	6.2	28.1	27.6	STP	-0.5	-0.018
245	4CB	9.0	9.3	10.3	7.9	9.7	9.2	28.9	26.3	STP	-2.6	-0.090
246	3S2	8.4	7.7	14.3	12.0	9.4	9.8	32.1	29.5	STP	-2.6	-0.081
247	2SG	9.4	10.9	11.9	8.6	.	.	21.3	19.5	STP	-1.8	-0.085
248	3S2	9.9	9.6	14.2	14.6	9.3	8.4	33.3	32.7	STP	-0.6	-0.018
249	3S2	9.1	9.2	33.3	32.0	31.2	33.8	73.6	75.0	STP	1.4	0.019
250	3SG	12.7	9.2	20.4	20.0	.	.	33.1	29.3	STP	-3.8	-0.115
251	3S2	9.7	7.3	25.4	25.4	11.6	11.8	46.7	44.6	STP	-2.1	-0.045
252	3S2	9.6	10.3	14.2	13.0	9.4	8.8	33.2	32.1	STP	-1.1	-0.033
253	3S2	9.7	7.6	18.8	11.4	14.1	13.6	42.6	32.5	STP	-10.1	-0.237
254	3S2	8.9	9.2	11.9	7.0	8.8	9.6	29.7	25.8	STP	-3.9	-0.131
255	4CB	8.4	8.4	9.3	6.7	10.5	9.8	28.2	24.9	STP	-3.3	-0.117
256	3S2	9.2	7.9	11.0	11.8	8.0	8.0	28.2	27.7	STP	-0.5	-0.018
257	3S2	9.6	9.3	32.8	36.0	32.6	32.4	75.0	77.7	STP	2.7	0.036
258	4CB	7.8	7.9	17.4	17.0	12.9	12.8	38.1	37.7	STP	-0.4	-0.010
259	3S2	9.2	9.2	32.6	31.0	28.7	30.6	70.5	70.9	STP	0.4	0.006
260	3S2	9.4	9.9	30.1	27.6	31.8	33.6	71.2	71.0	STP	-0.2	-0.003
261	3S2	10.7	7.9	29.6	30.2	12.8	15.7	53.1	53.8	STP	0.7	0.013
262	3S2	11.2	11.8	32.2	30.0	32.8	34.4	76.2	76.2	STP	0.0	0.000
263	3S2	11.1	10.8	32.8	33.4	33.8	46.4	77.7	90.6	UTC	12.9	0.166
264	3S2	9.2	10.3	25.0	28.8	32.8	39.4	67.0	78.4	UTC	11.4	0.170
265	3S2	9.4	8.6	13.4	14.8	10.5	10.6	33.6	33.9	UTC	0.3	0.009
266	3S2	9.1	13.9	13.6	9.4	11.3	13.4	34.0	36.6	UTC	2.6	0.076
267	3S2	9.3	8.7	15.5	16.6	13.9	13.4	38.7	38.7	UTC	0.0	0.000
268	2SG	6.8	9.5	7.1	4.3	.	.	13.9	13.8	UTC	-0.1	-0.007
269	3S2	10.9	10.7	32.0	34.2	32.2	37.0	75.1	81.8	UTC	6.7	0.089
270	3S2	11.2	9.4	28.6	32.2	17.6	13.0	57.4	54.5	UTC	-2.9	-0.051
271	3S2	9.4	8.4	11.7	13.4	7.9	8.4	29.0	30.4	UTC	1.4	0.048
272	3S2	9.2	8.0	11.0	9.4	7.9	3.2	28.1	20.5	UTC	-7.6	-0.270
273	3S2	9.4	10.3	28.1	29.8	27.7	38.2	65.2	78.3	UTC	13.1	0.201
274	3S2	9.0	9.6	24.4	26.0	20.0	24.6	53.5	60.1	UTC	6.6	0.123
275	3S2	11.0	9.3	27.7	32.2	11.0	10.0	49.8	51.5	UTC	1.7	0.034

ONE-TO-ONE COMPARISONS
STATIC SCALE AND BRIDGE WIM TRUCK WEIGHTS

OBS	TRKTYPE	SSWGT	WSWGT	SDWGT	WDWGT	STWGT	WTWGT	SGWGT	WGWGT	SITE	DIFFG	PDIFG
276	3S2	8.3	8.5	25.1	27.8	16.8	19.4	50.2	55.7	UTC	5.5	0.110
277	2SG	10.9	18.4	11.6	6.8	.	.	22.5	25.1	UTC	2.6	0.116
278	3S2	8.6	10.2	32.2	35.4	28.5	29.0	69.3	74.6	UTC	5.3	0.076
279	3S2	11.6	9.3	21.5	23.4	17.5	20.2	50.6	52.9	UTC	2.3	0.045
280	4CB	8.2	14.0	15.1	13.5	16.2	16.8	39.5	44.5	UTC	5.0	0.127
281	3S2	10.2	9.1	19.4	22.0	15.4	15.6	45.0	46.7	UTC	1.7	0.038
282	3S2	10.9	10.3	32.3	36.2	31.0	30.6	74.2	77.2	UTC	3.0	0.040
283	3S2	11.9	10.3	26.8	29.6	30.9	37.6	69.7	77.5	UTC	7.8	0.112
284	4CB	8.8	8.2	10.5	13.8	9.7	9.8	28.9	31.8	UTC	2.9	0.100
285	3S2	10.2	10.6	19.6	21.6	16.2	17.4	45.9	49.6	UTC	3.7	0.081
286	3S2	8.7	10.8	30.7	34.0	31.1	45.6	70.5	90.6	UTC	20.1	0.285
287	3S2	9.0	12.3	28.4	29.2	28.1	28.4	65.5	69.8	UTC	4.3	0.066
288	3S2	9.2	9.7	26.5	26.0	28.1	26.4	63.7	62.0	UTC	-1.7	-0.027
289	3S2	8.9	12.2	12.0	7.0	8.4	8.6	29.3	27.7	UTC	-1.6	-0.055
290	3S2	9.6	10.5	33.3	35.0	30.4	37.6	73.2	83.2	UTC	10.0	0.137
291	3S2	8.9	11.5	21.3	17.2	19.6	20.6	49.7	49.2	UTC	-0.5	-0.010
292	3S2	8.9	8.7	12.2	9.4	10.3	9.8	31.3	28.0	UTC	-3.3	-0.105
293	3S2	9.6	10.4	26.7	33.8	30.9	34.4	67.2	78.5	UTC	11.3	0.168
294	3S2	9.5	10.1	28.3	27.6	28.9	34.0	66.7	71 7	UTC	5.0	0.075
295	3S2	9.7	8.7	15.7	18.2	11.3	10.6	36.7	37.6	UTC	0.9	0.025
296	3S2	8.6	8.4	11.4	13.4	7.3	8.6	27.3	30.4	UTC	3.1	0.114
297	4CB	9.4	9.2	12.4	14.6	16.1	18.0	37.9	41.9	UTC	4.0	0.106
298	3S2	10.2	10.9	32.3	38.2	31.3	42.2	73.8	91.3	UTC	17.5	0.237
299	3S2	9.2	10.6	32.3	37.4	31.9	36.4	73.4	84.5	UTC	11.1	0.151
300	3S2	9.4	9.7	11.2	10.0	8.3	8.6	28.8	28.4	UTC	-0.4	-0.014
301	3S2	9.9	12.8	29.4	29.6	31.8	40.4	71.1	82.8	UTC	11.7	0.165
302	3S2	9.2	9.0	23.2	23.6	12.2	13.2	44.5	45.8	UTC	1.3	0.029
303	3S2	10.1	11.2	33.3	35.2	34.1	36.0	77.5	82.5	UTC	5.0	0.065
304	3S2	9.4	9.1	22.2	25.0	10.5	12.6	42.1	46.8	UTC	4.7	0.112
305	3S2	9.8	11.3	28.1	26.0	28.7	29.0	66.5	66.3	UTC	-0.2	-0.003
306	3S2	10.2	9.9	32.1	32.2	26.8	26.4	69.0	68.6	UTC	-0.4	-0.006
307	4CB	7.6	7.9	11.4	11.9	12.2	9.2	31.2	28.9	UTC	-2.3	-0.074
308	3S2	8.6	10.1	10.4	7.8	7.6	7.8	26.5	25.8	UTC	-0.7	-0.026
309	3S2	10.7	10.6	29.7	39.4	29.1	35.0	69.5	84.9	UTC	15.4	0.222
310	3S2	10.3	10.8	33.3	35.4	34.0	43.4	77.7	89.5	UTC	11.8	0.152
311	3S2	10.0	10.7	31.8	35.4	30.9	42.0	72.7	88.2	UTC	15.5	0.213
312	3S2	10.9	10.5	26.7	27.6	28.7	28.4	66.3	66.6	UTC	0.3	0.005
313	3S2	9.8	10.1	33.2	29.4	31.6	32.4	74.6	72.0	UTC	-2.6	-0.035

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APPENDIX IV

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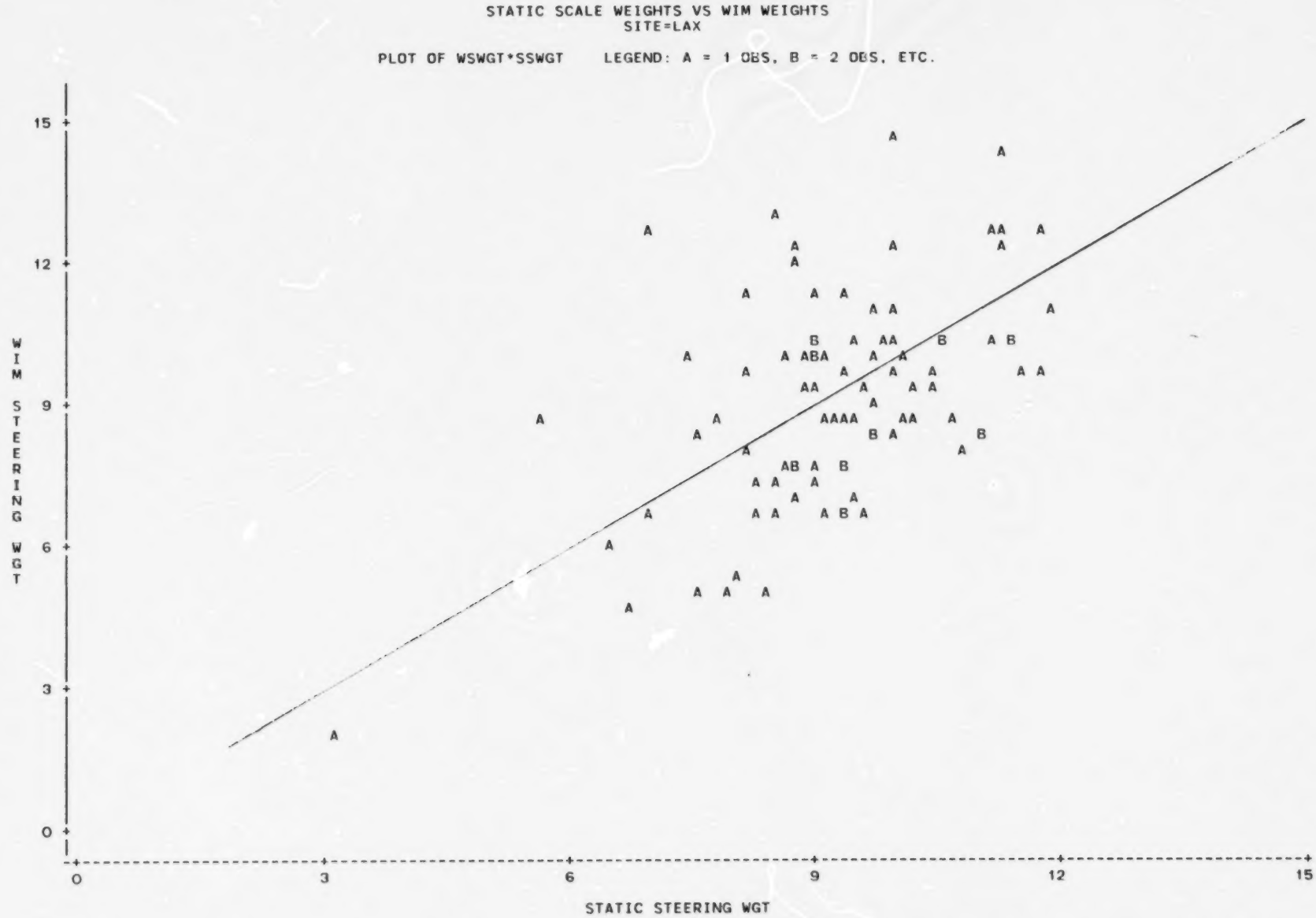

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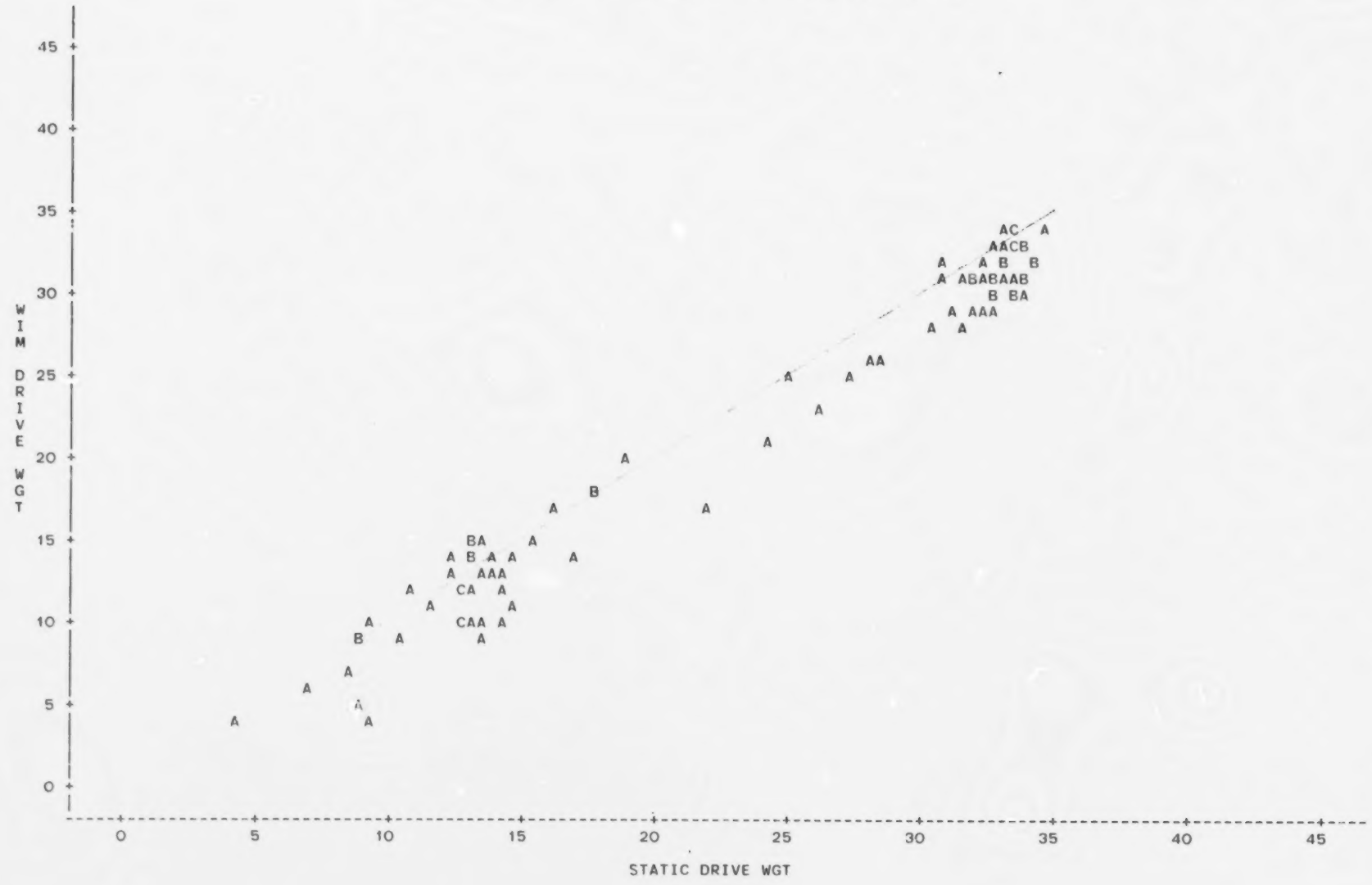
STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=LAX

PLOT OF WDWGT*SDWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



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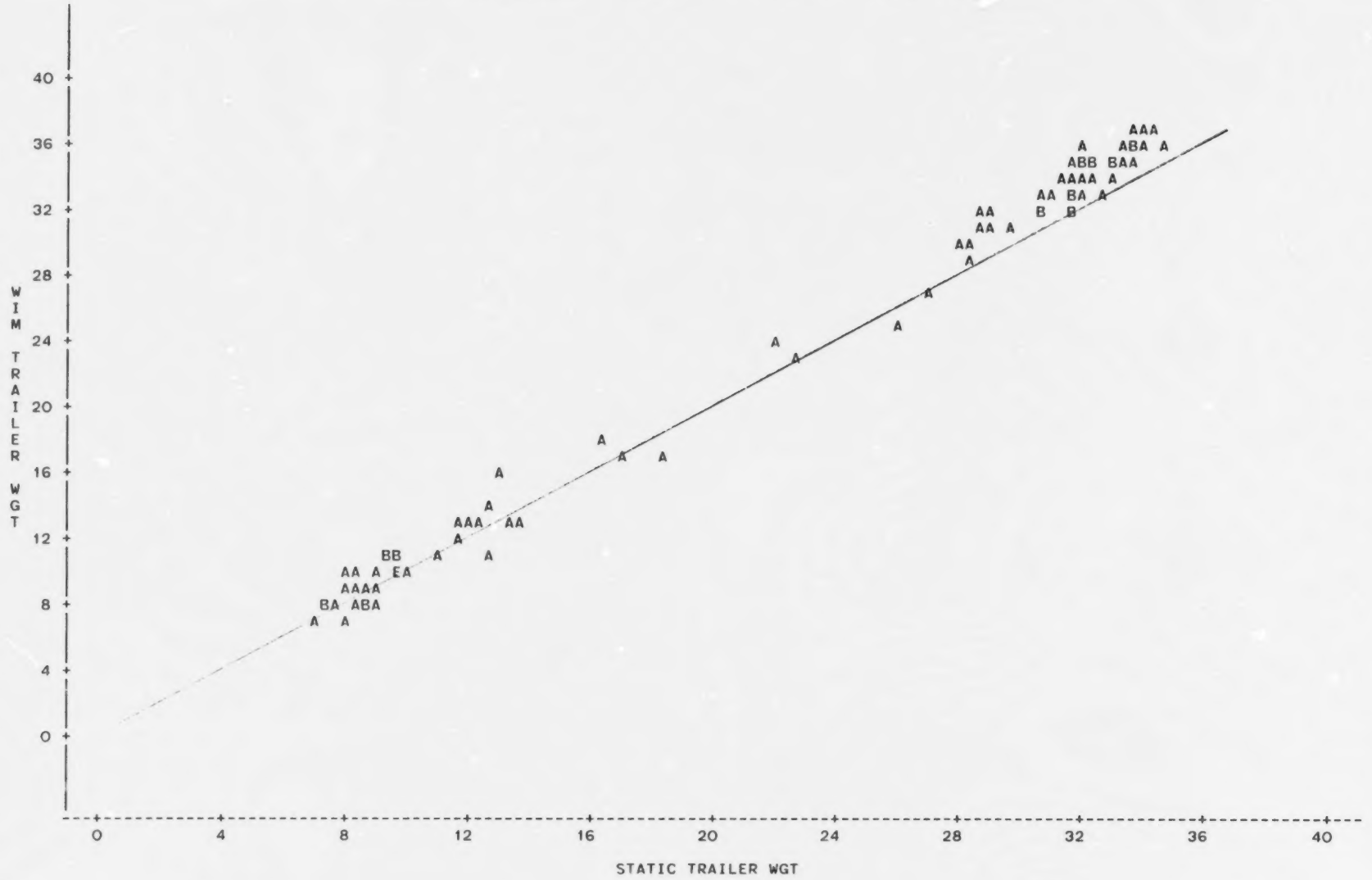
STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=LAX

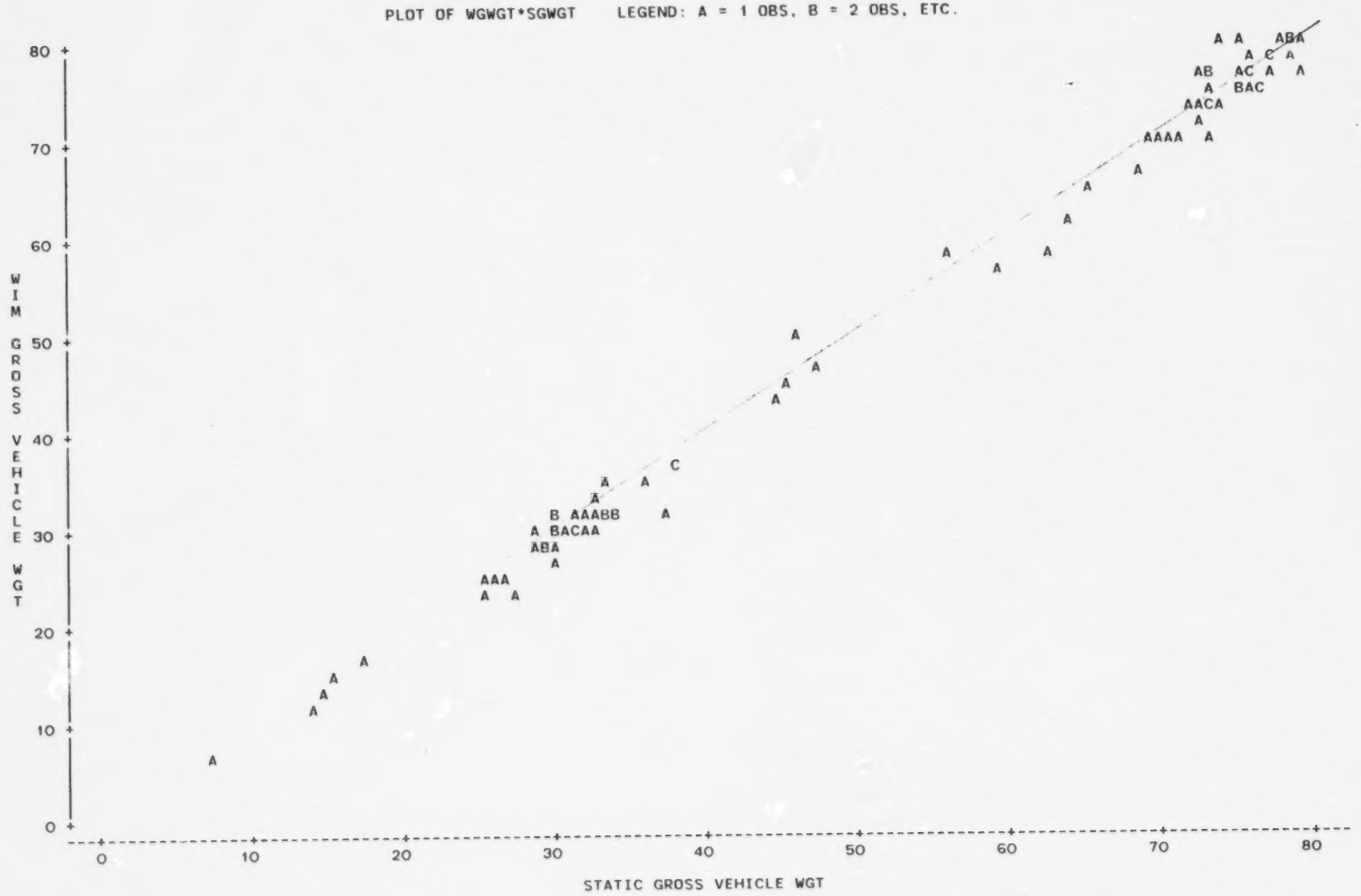
PLOT OF WTWGT*STWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 5 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=LAX

PLOT OF WGWGT*SGWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



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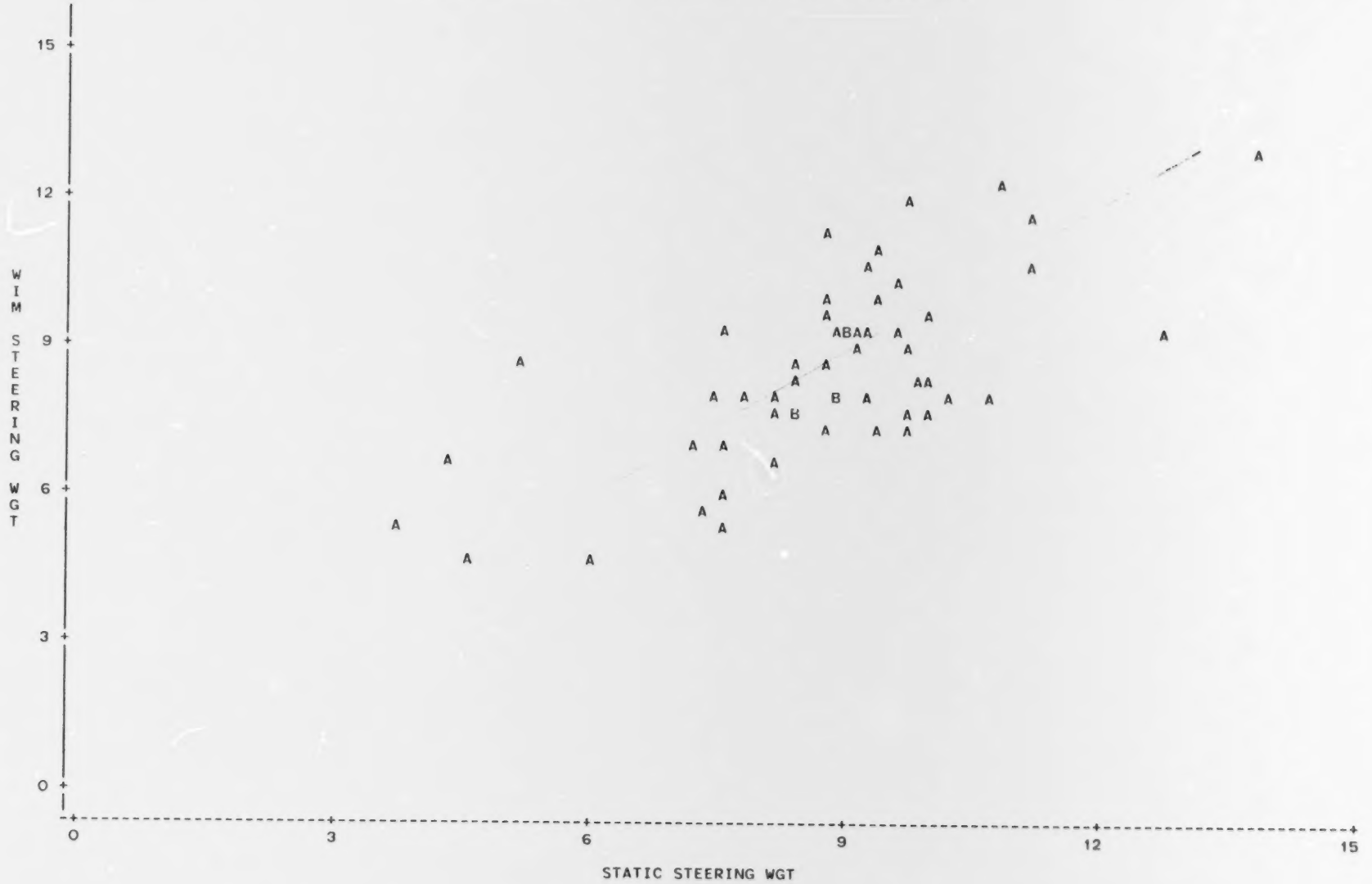
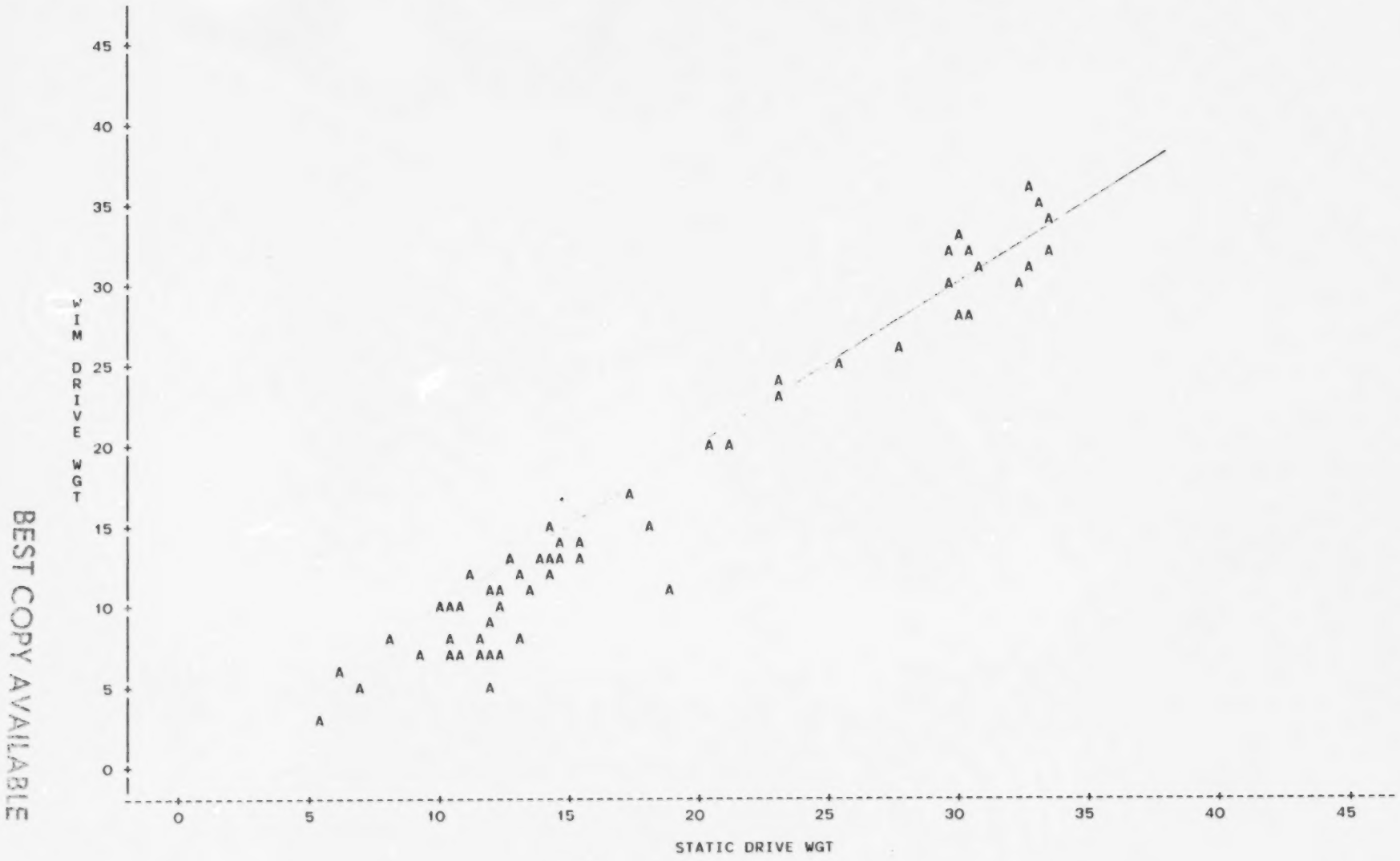
STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=STP

PLOT OF WSWGT*SSWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.





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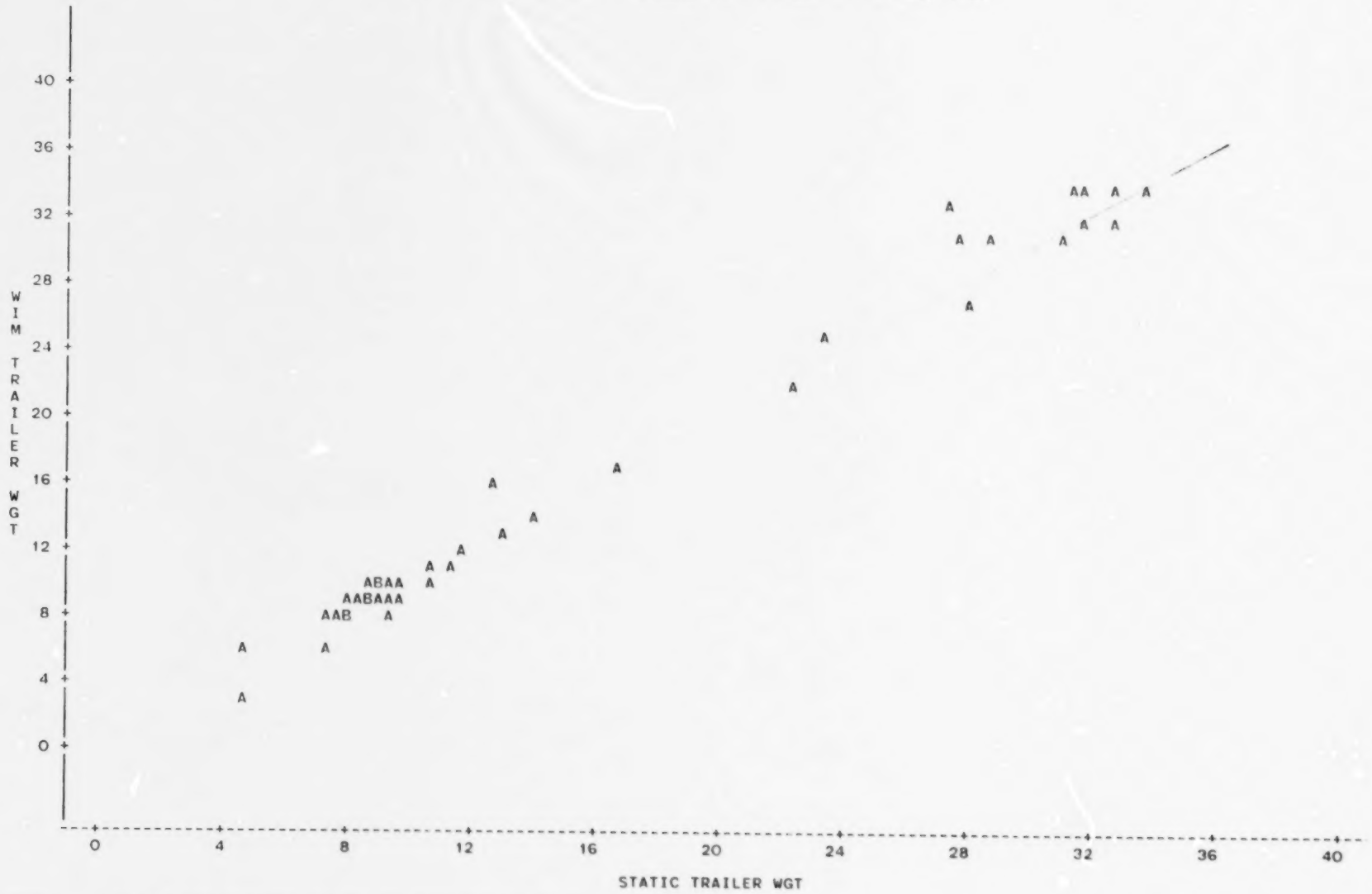
STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=STP

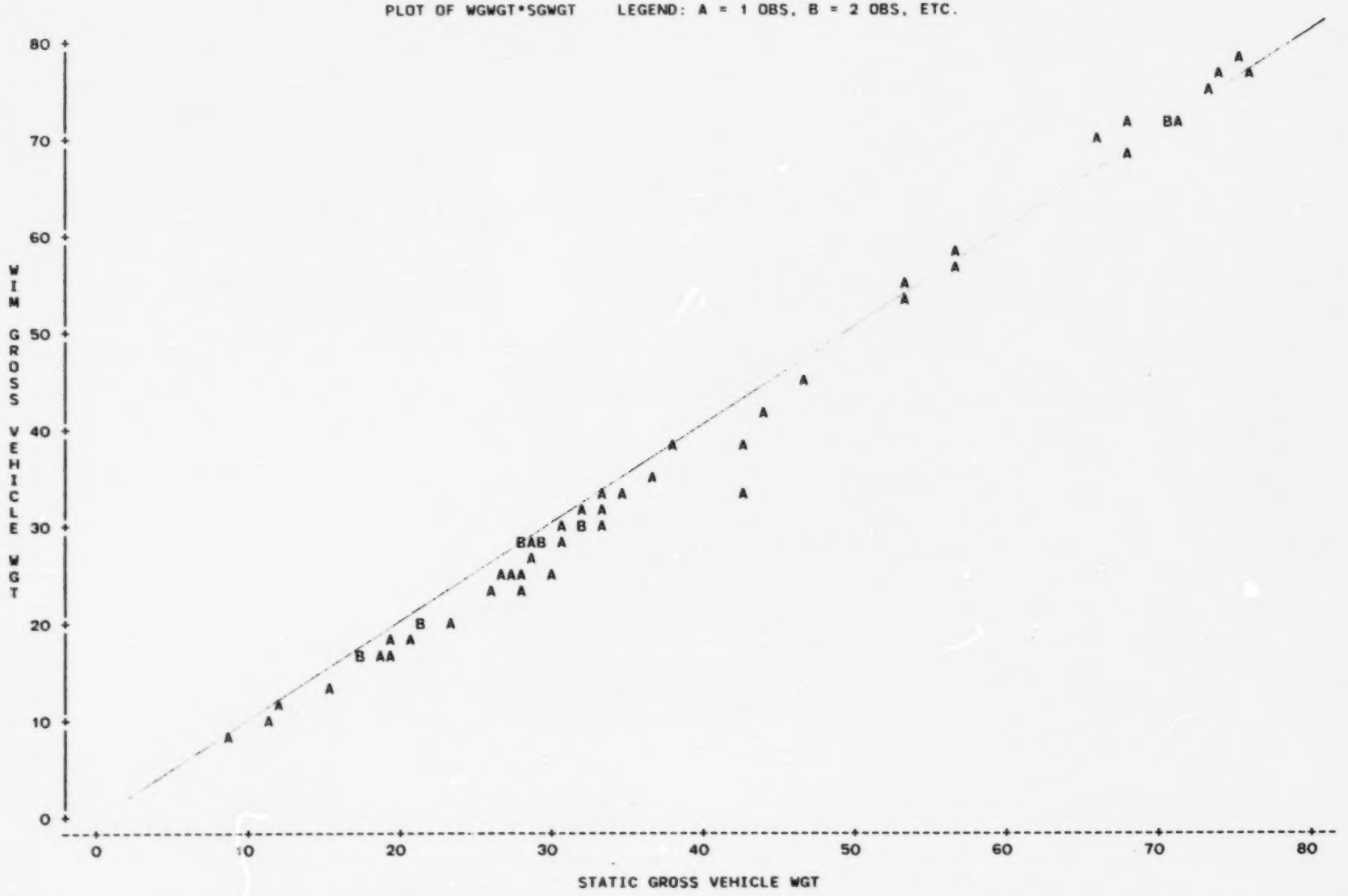
PLOT OF WTWGT*STWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 14 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=STP

PLOT OF WGWGT*SGWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 1 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

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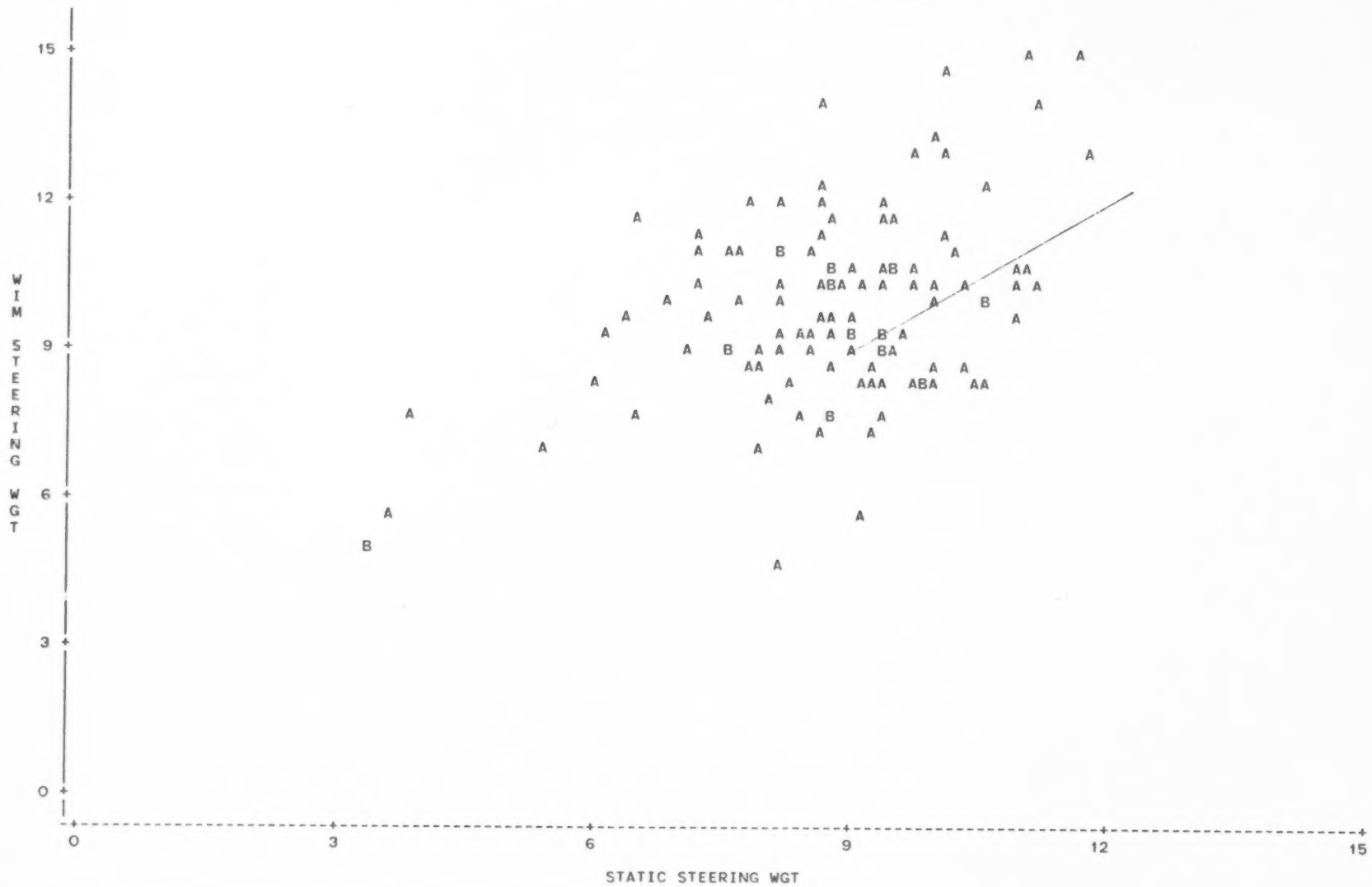
STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=MNC

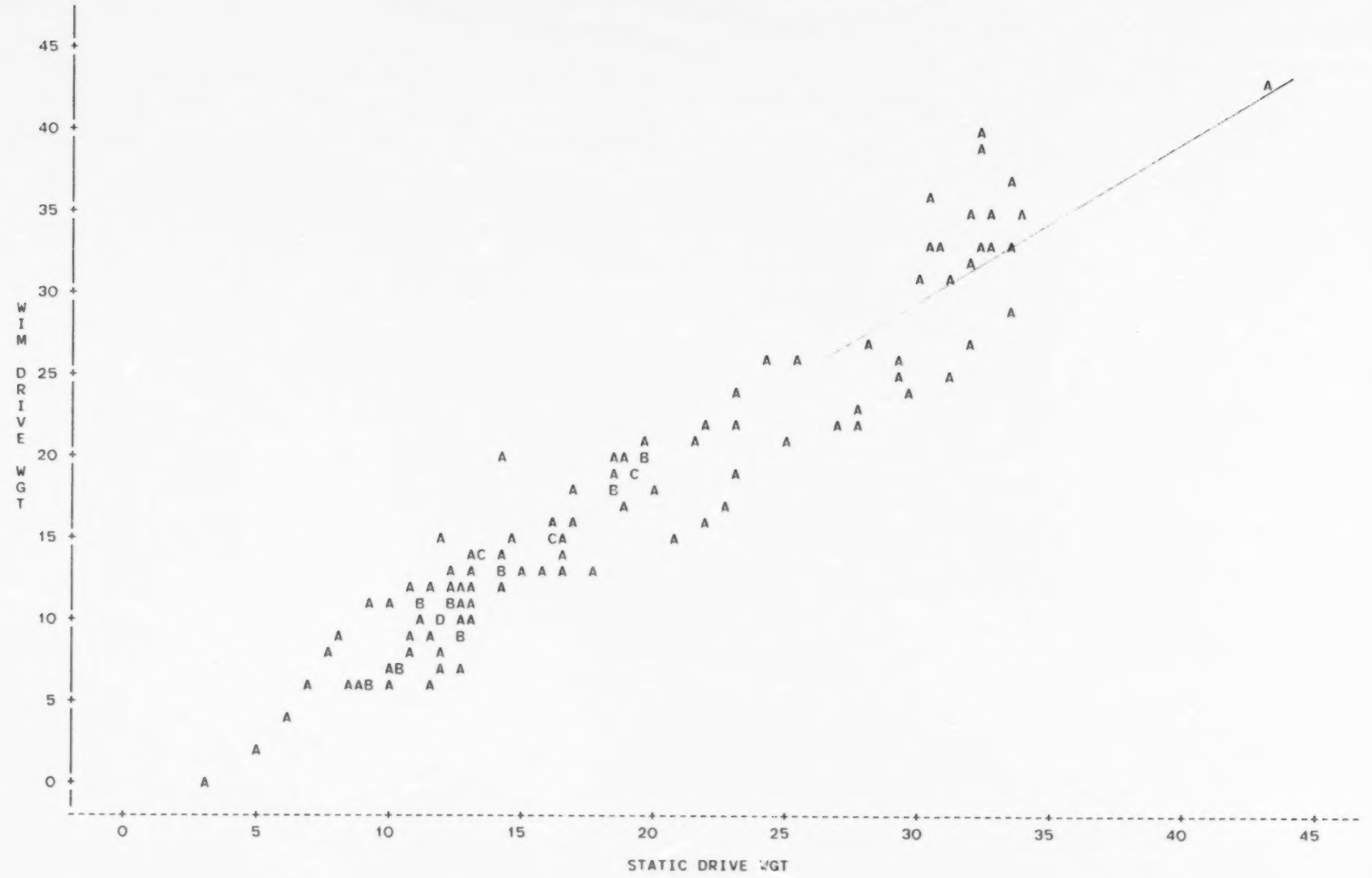
PLOT OF WSWGT*SSWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 2 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=MNC

PLOT OF WDWGT*SDWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



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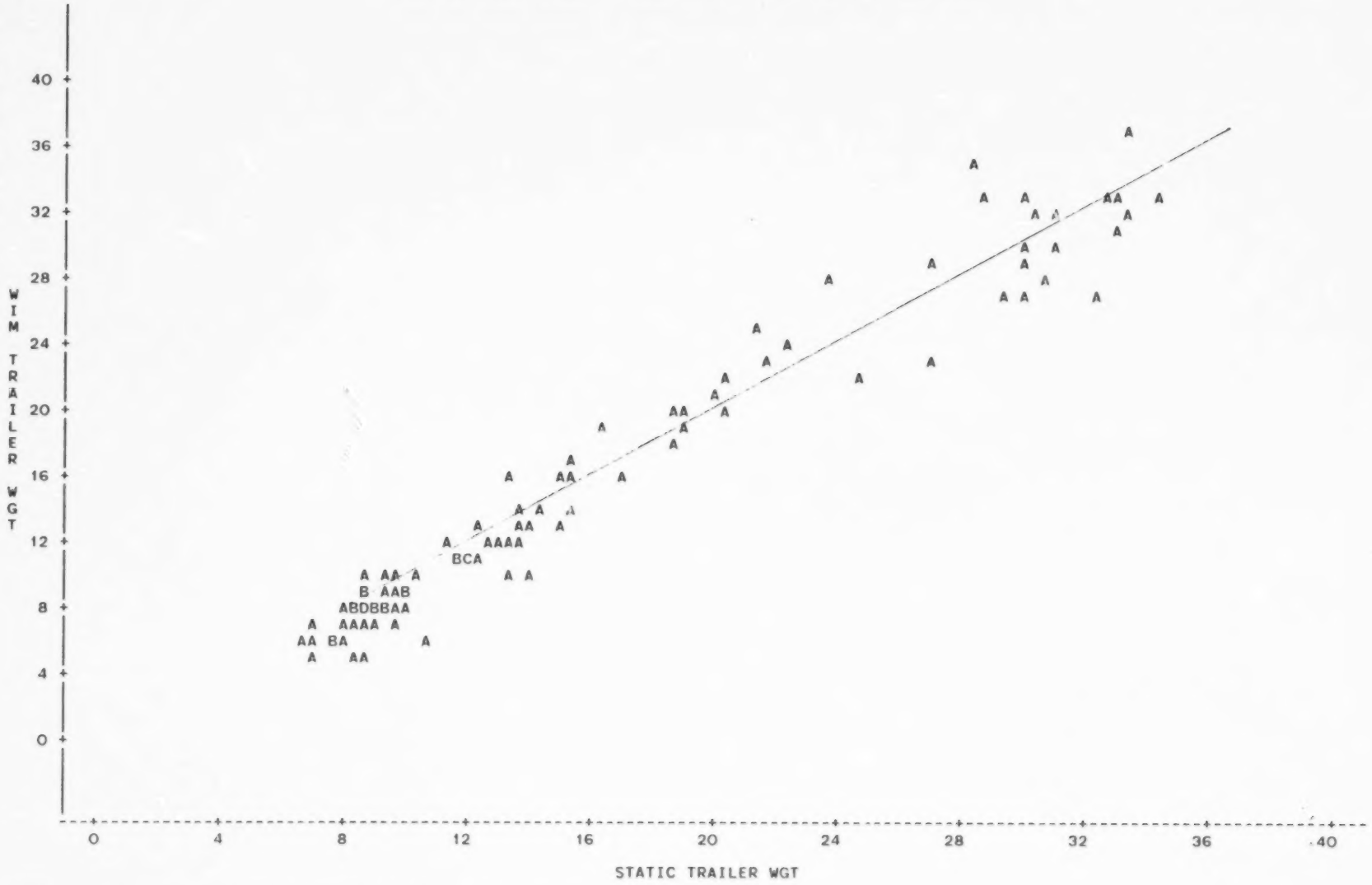
STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=MNC

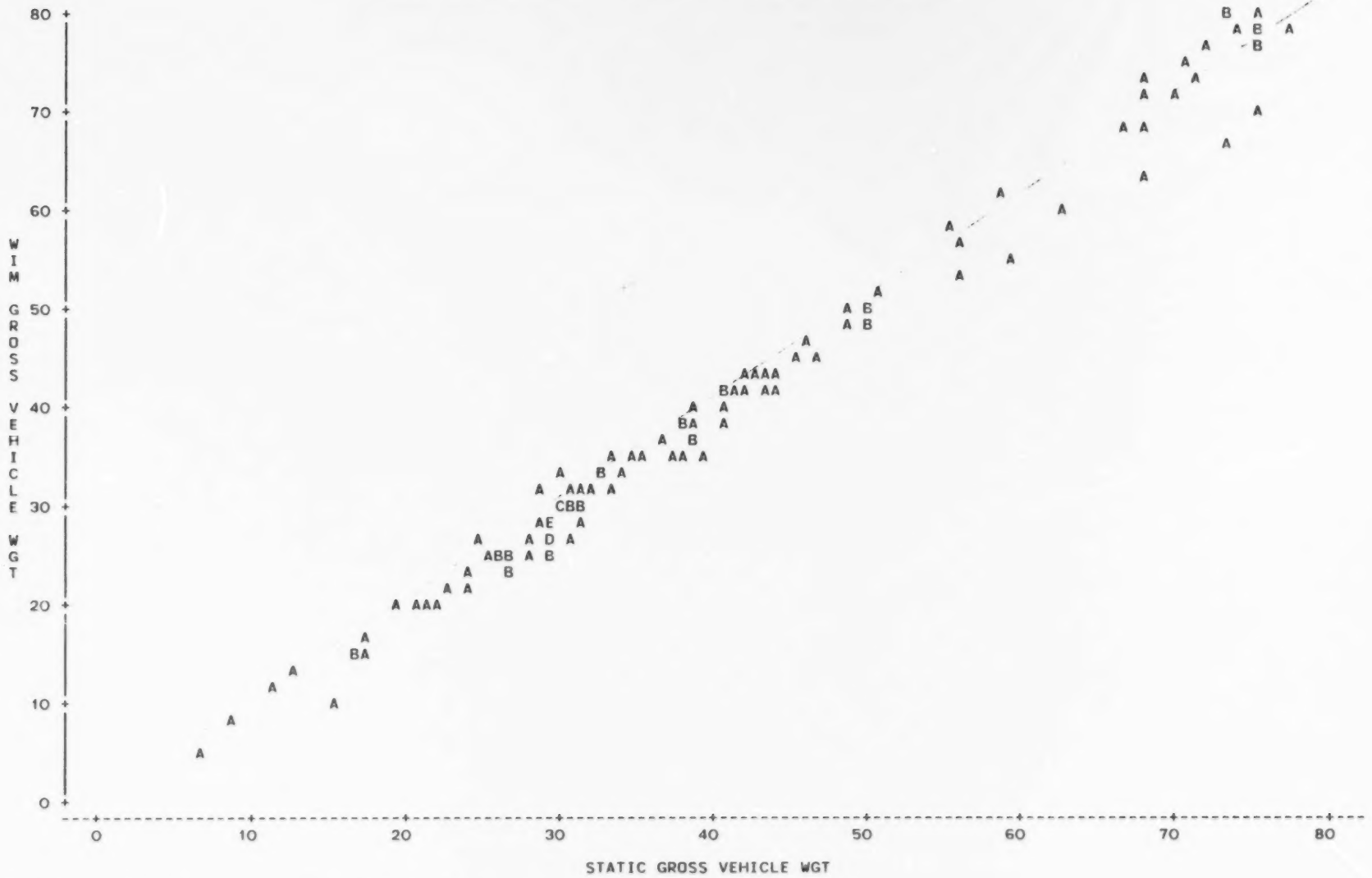
PLOT OF WTWGT*STWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 22 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=MNC

PLOT OF WGWGT*SGWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 1 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

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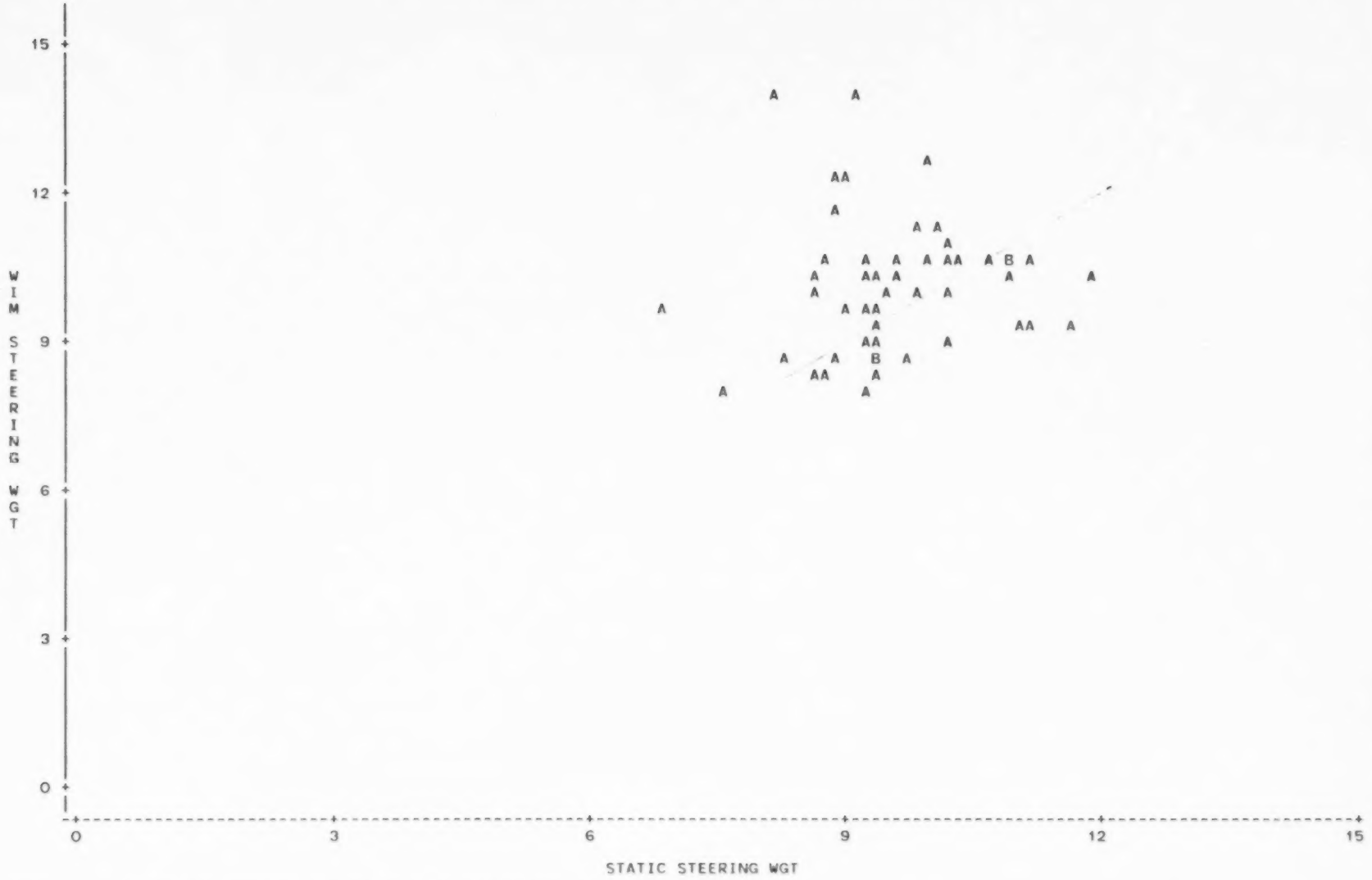
STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=UTC

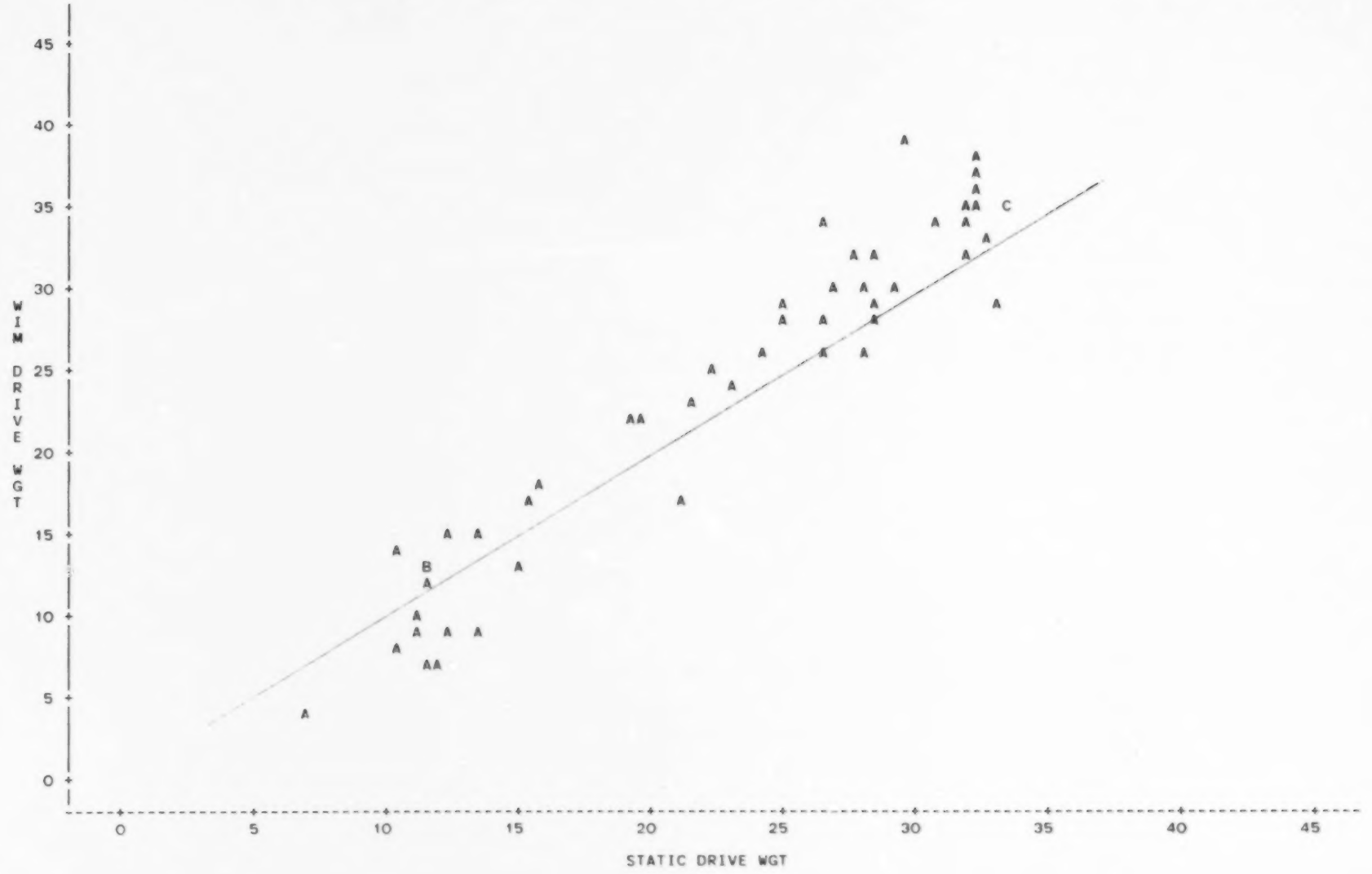
PLOT OF WSWGT*SSWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 1 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=UTC

PLOT OF WDWGT*SDWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



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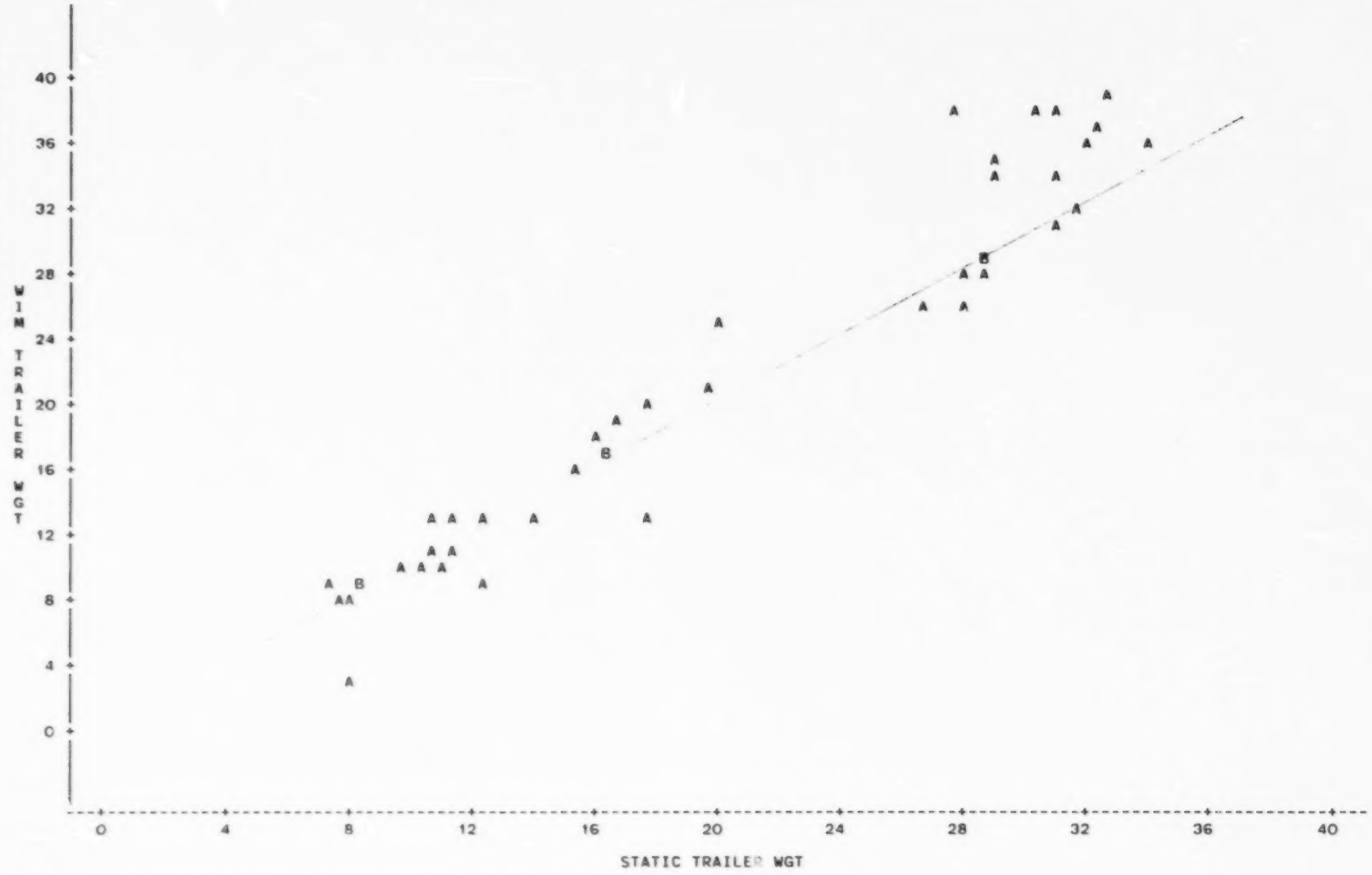
STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=UTC

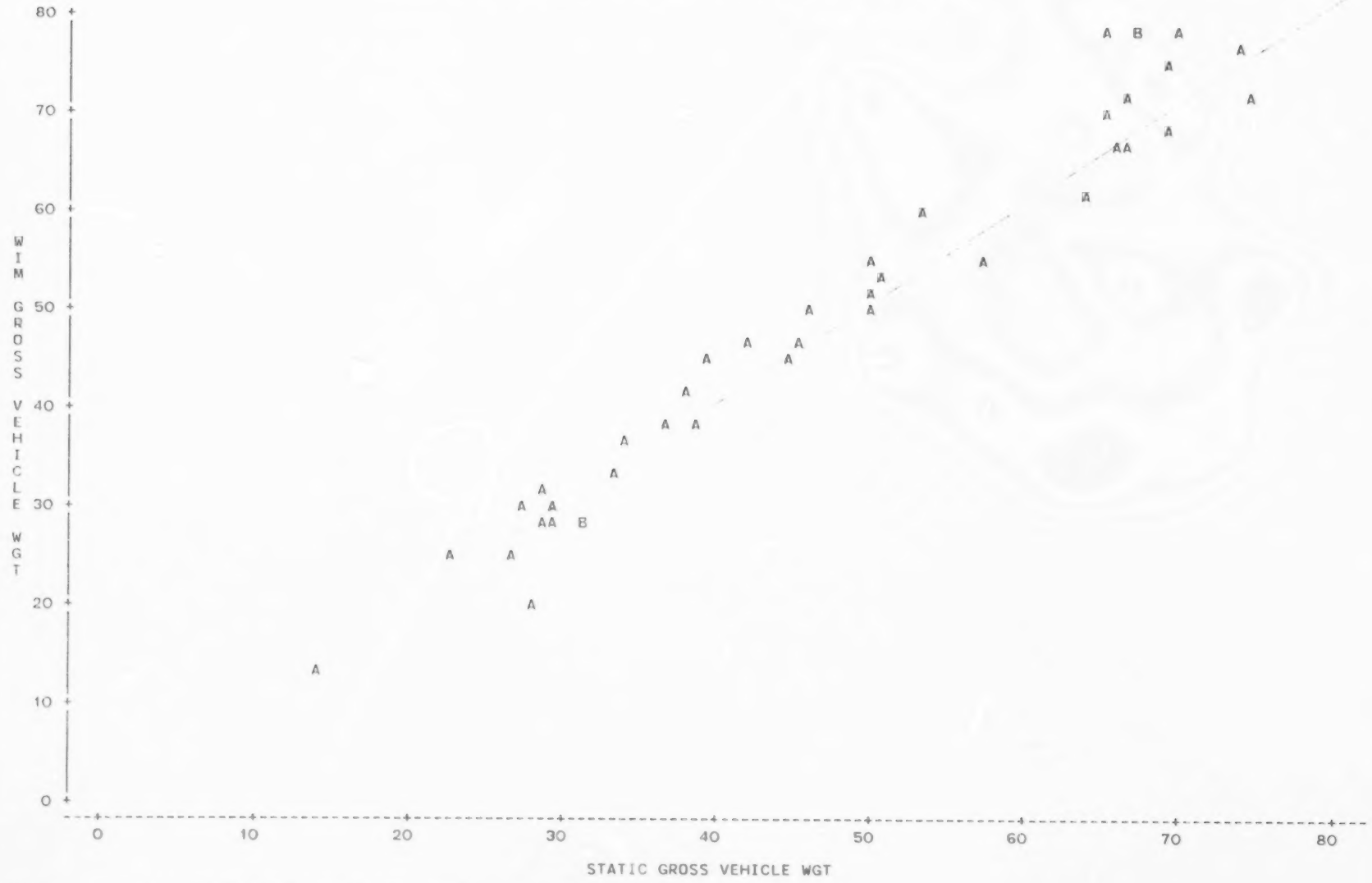
PLOT OF WTWGT*STWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 8 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

STATIC SCALE WEIGHTS VS WIM WEIGHTS
SITE=UTC

PLOT OF WGWGT*SGWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 11 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

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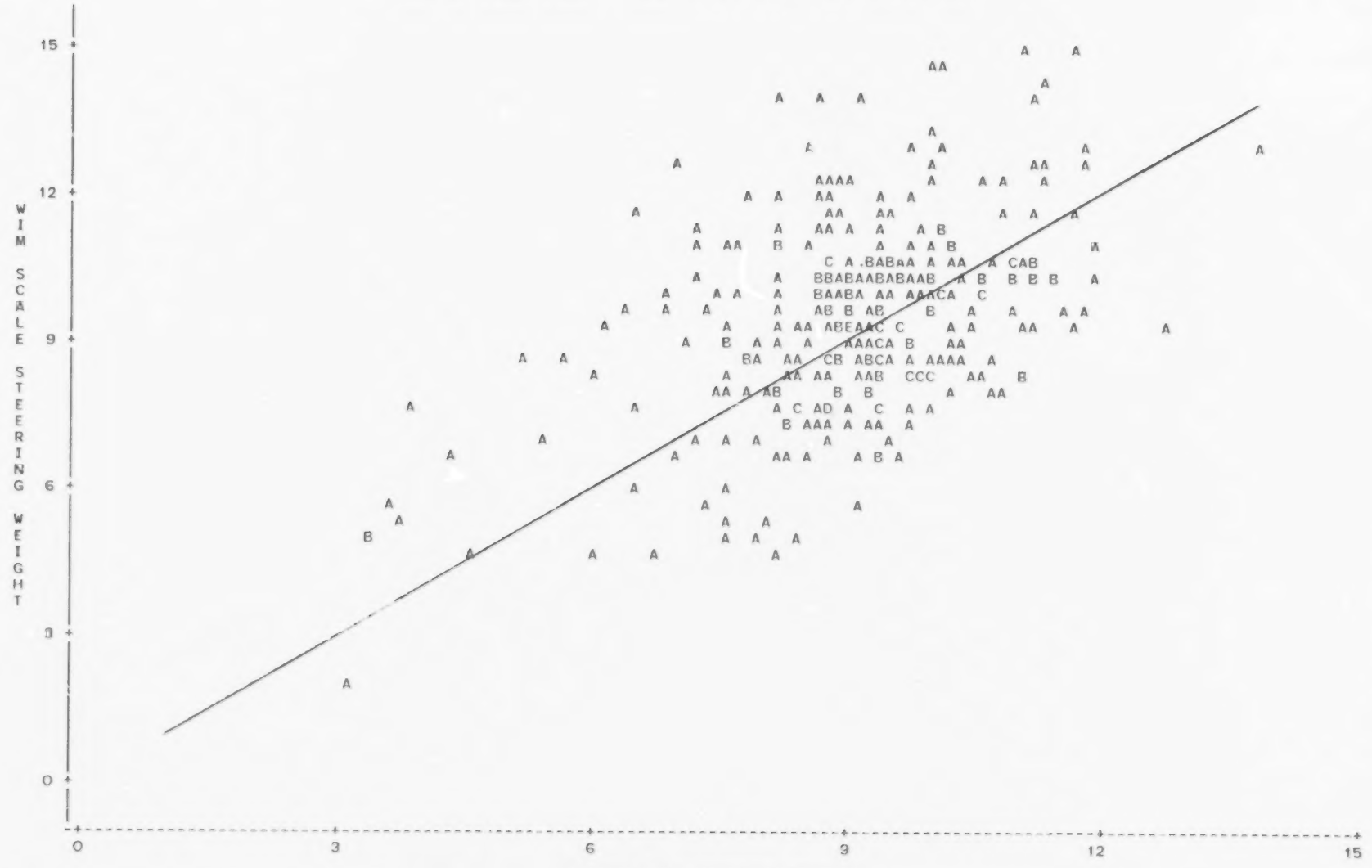
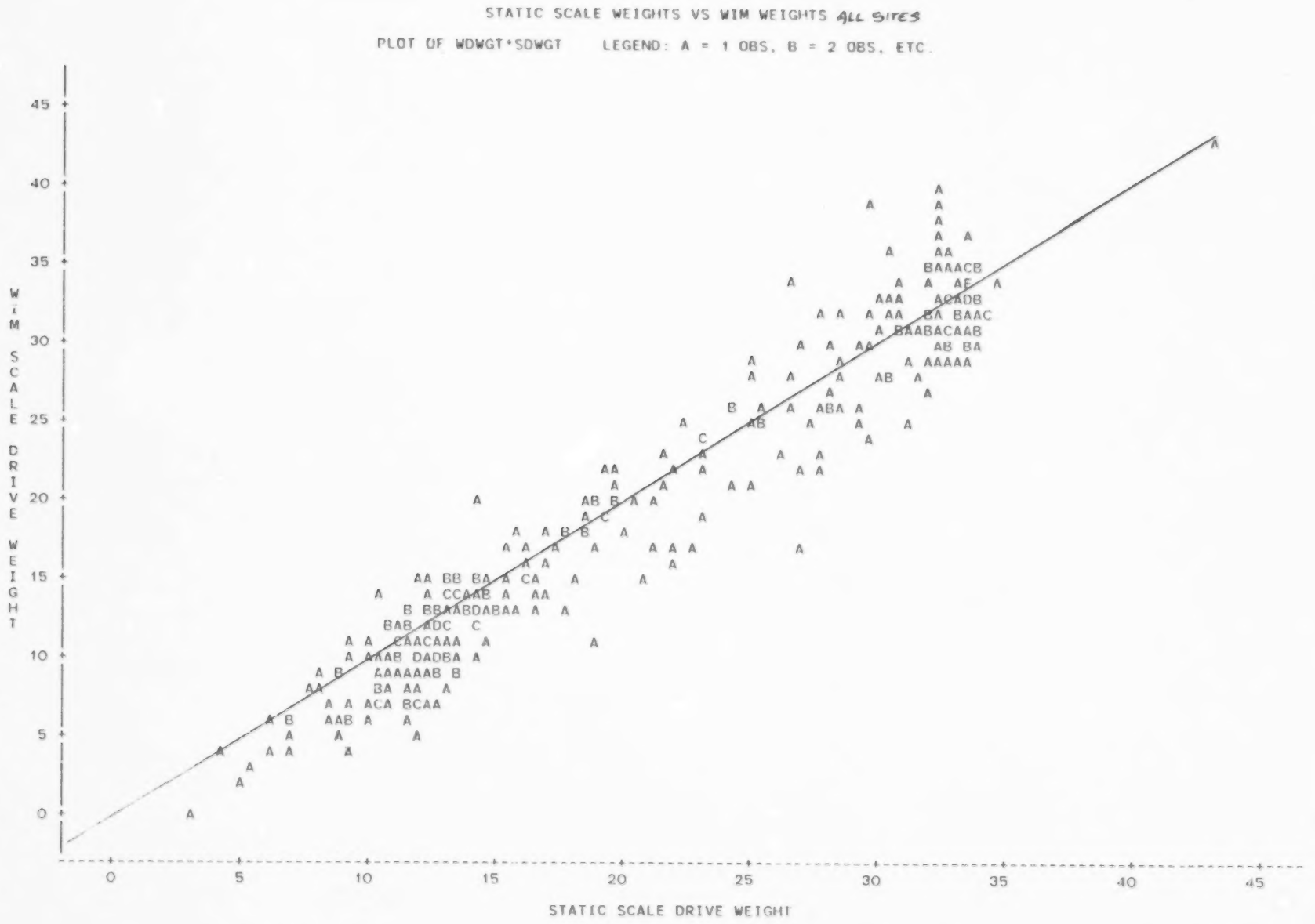
STATIC SCALE WEIGHTS VS WIM WEIGHTS *ALL SITES*

PLOT OF WSWGT*SSWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 3 OBS HAD MISSING VALUES OR WERE OUT OF RANGE



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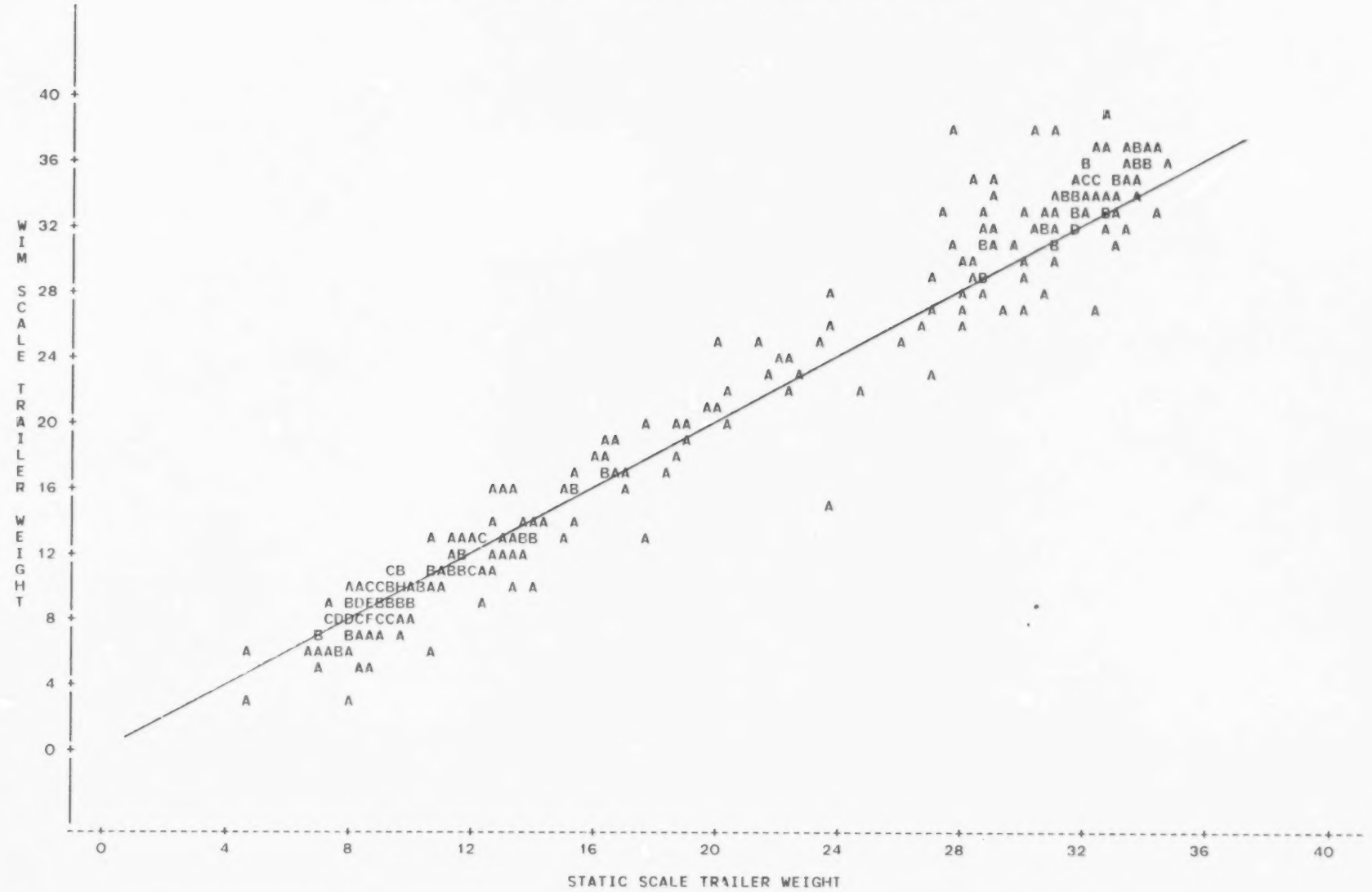
STATIC SCALE WEIGHTS VS WIM WEIGHTS ALL SITES

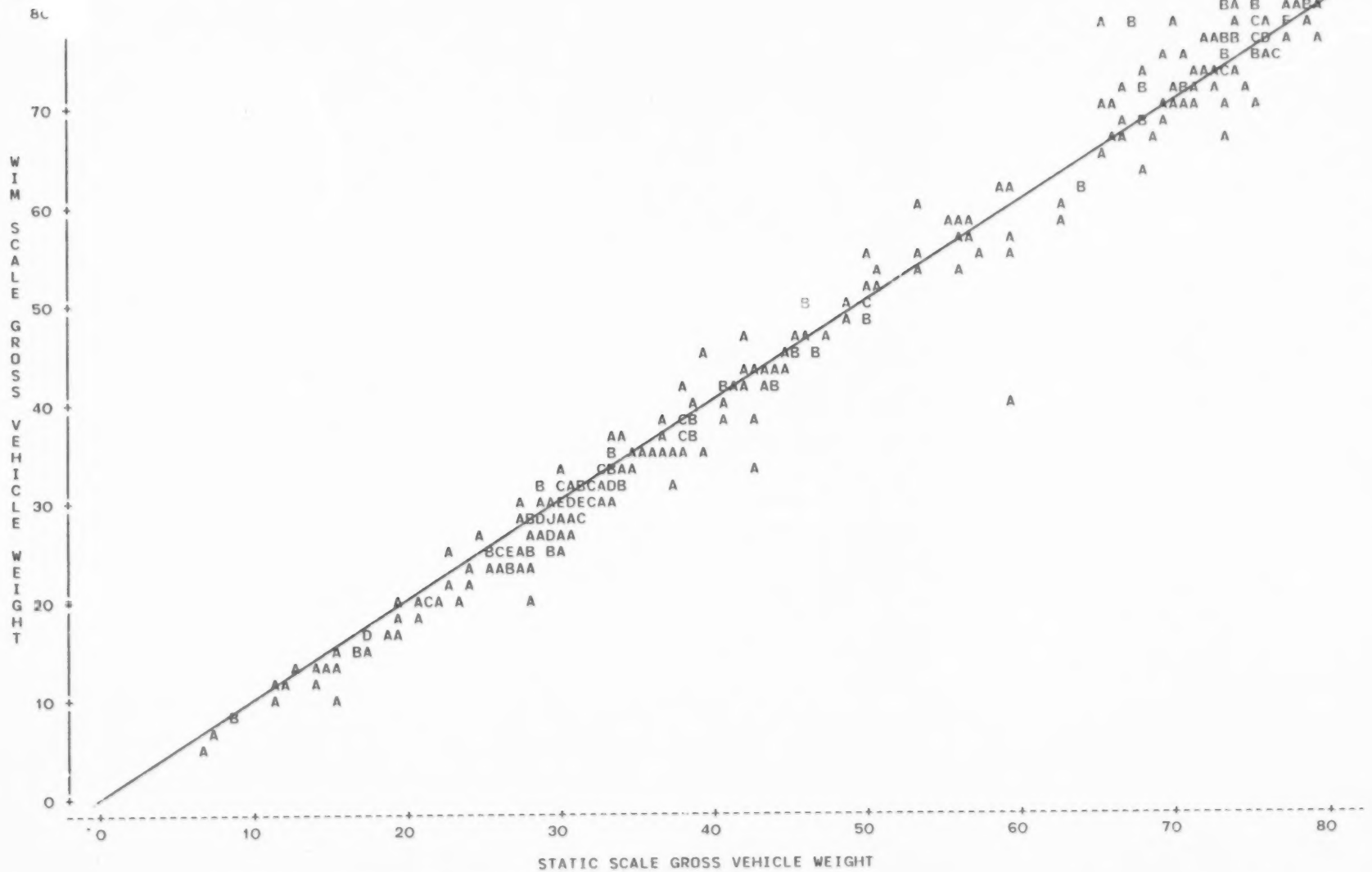
PLOT OF WTWGT*STWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 49 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

STATIC SCALE WEIGHTS VS WIM WEIGHTS ALL SITES

PLOT OF WGWGT*SGWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 14 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

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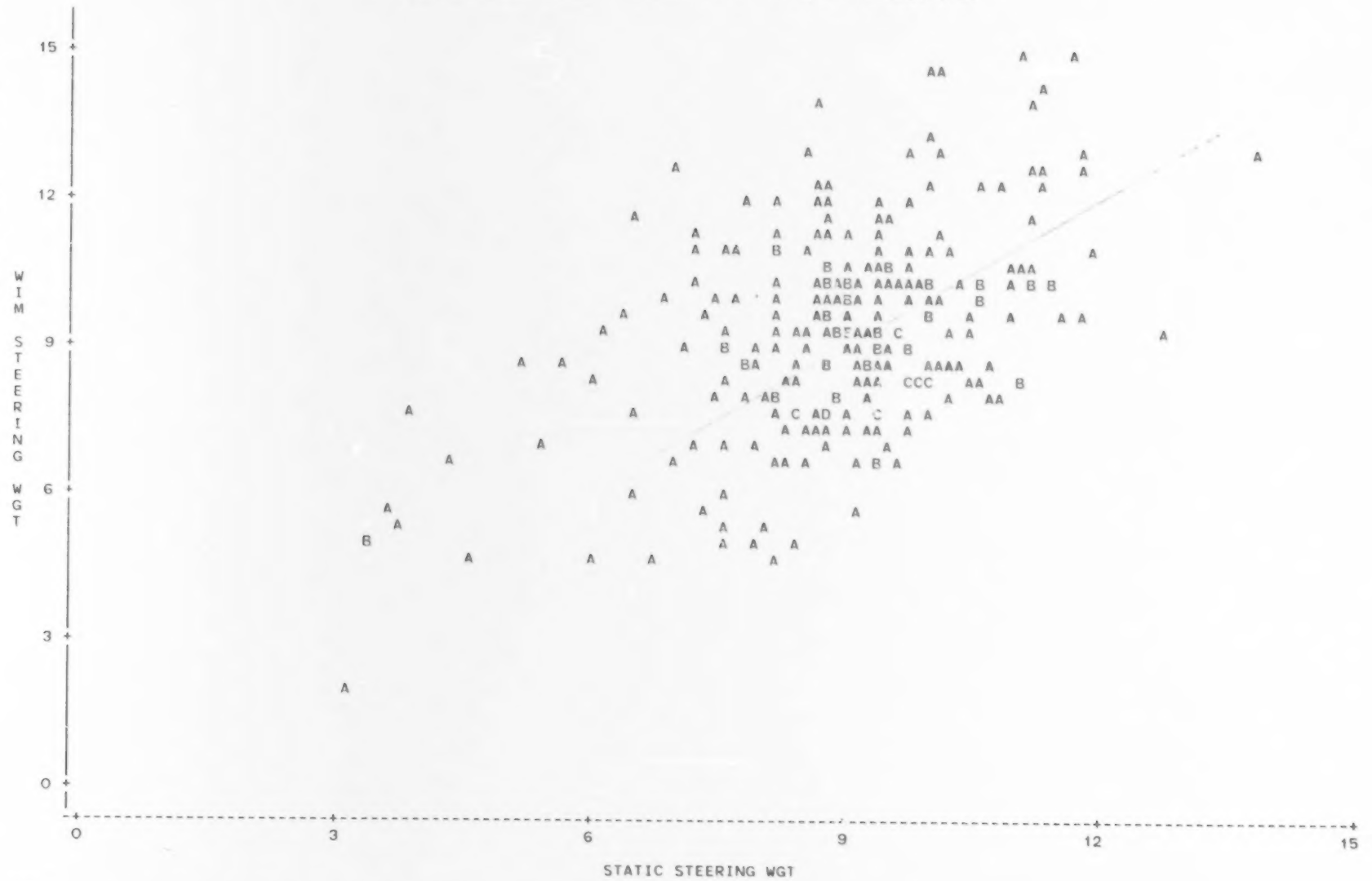
STATIC SCALE WEIGHTS VS WIM WEIGHTS
ALL SITES EXCEPT UTICA

PLOT OF WSWGT*SSWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 2 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

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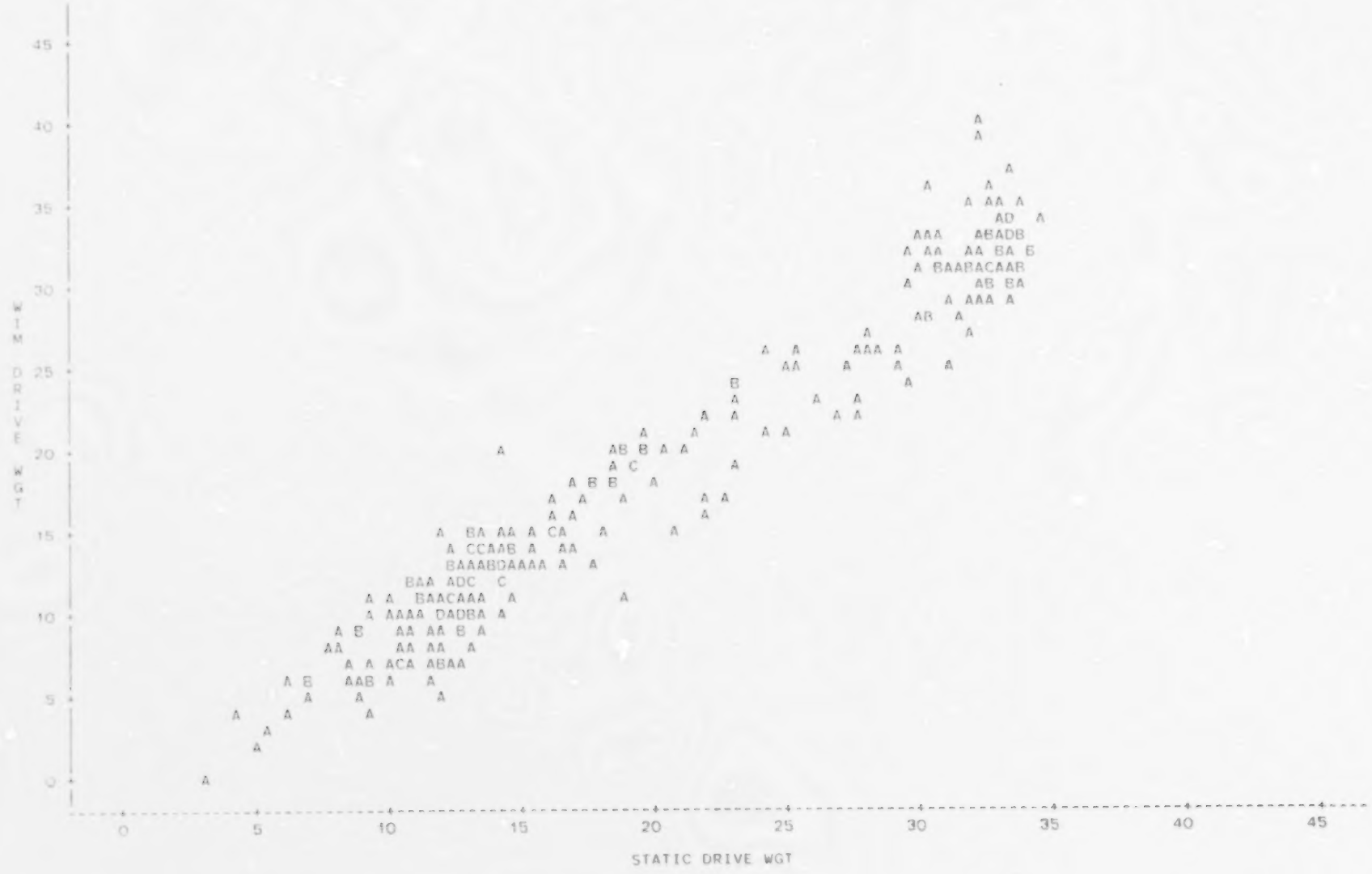
STATIC SCALE WEIGHTS VS WIM WEIGHTS
ALL SITES EXCEPT UTICA

PLOT OF WDWGT*SDWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



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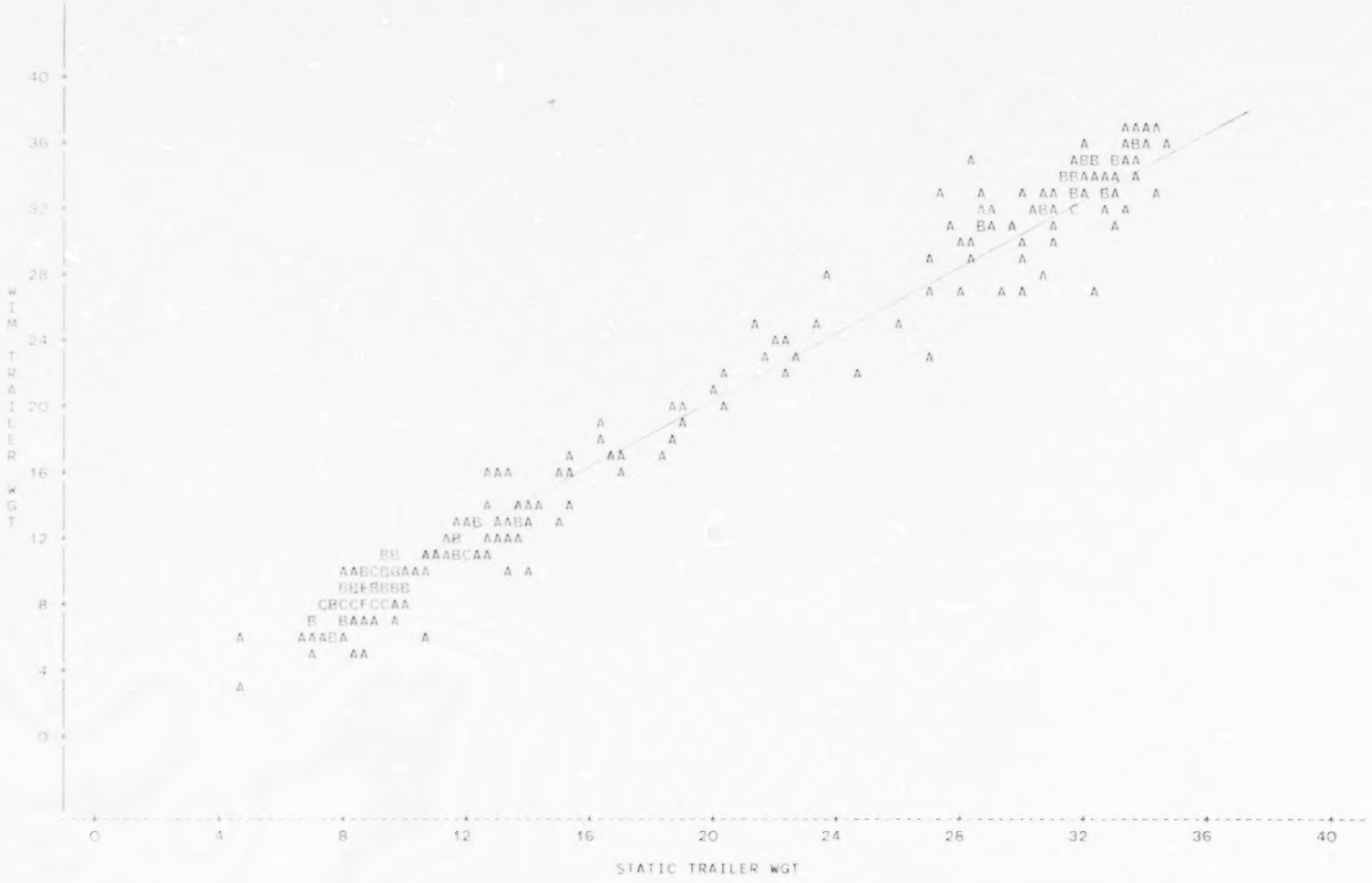
STATIC SCALE WEIGHTS VS WIM WEIGHTS
ALL SITES EXCEPT UTICA

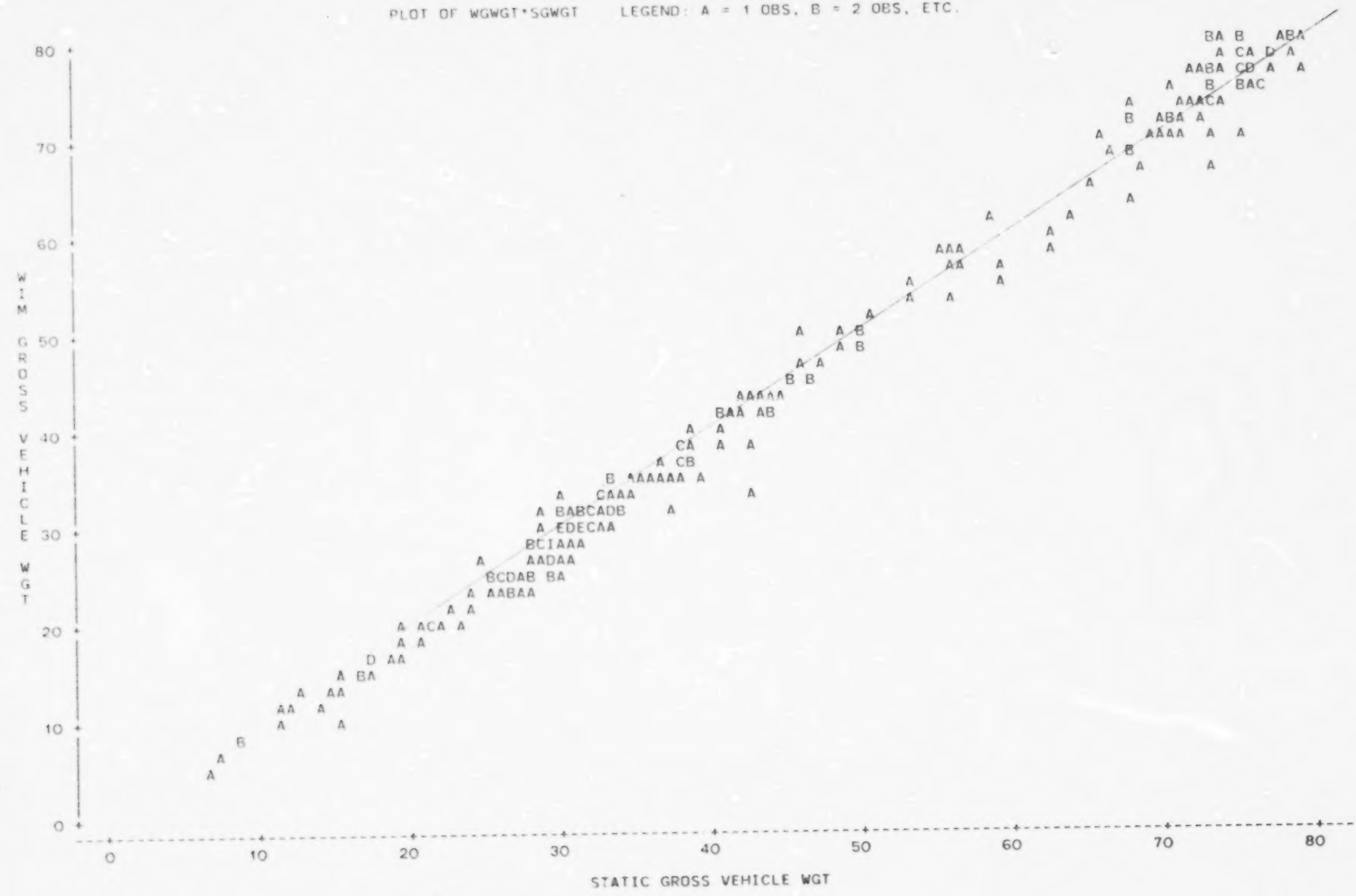
PLOT OF WTWGT*STWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC



NOTE: 41 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

STATIC SCALE WEIGHTS VS WIM WEIGHTS
ALL SITES EXCEPT UTICA

PLOT OF WGWGT*SGWGT LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 2 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

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APPENDIX V

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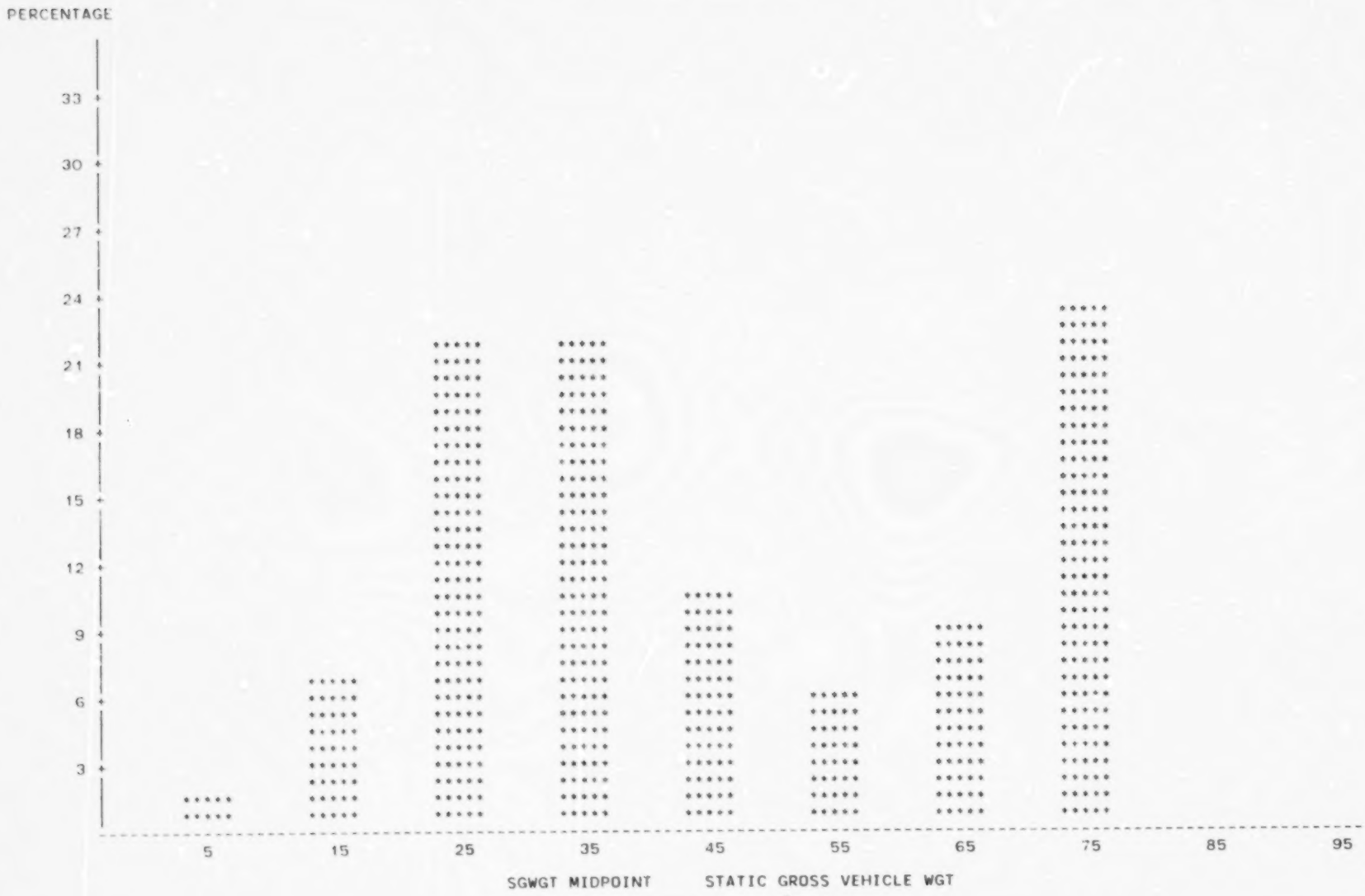
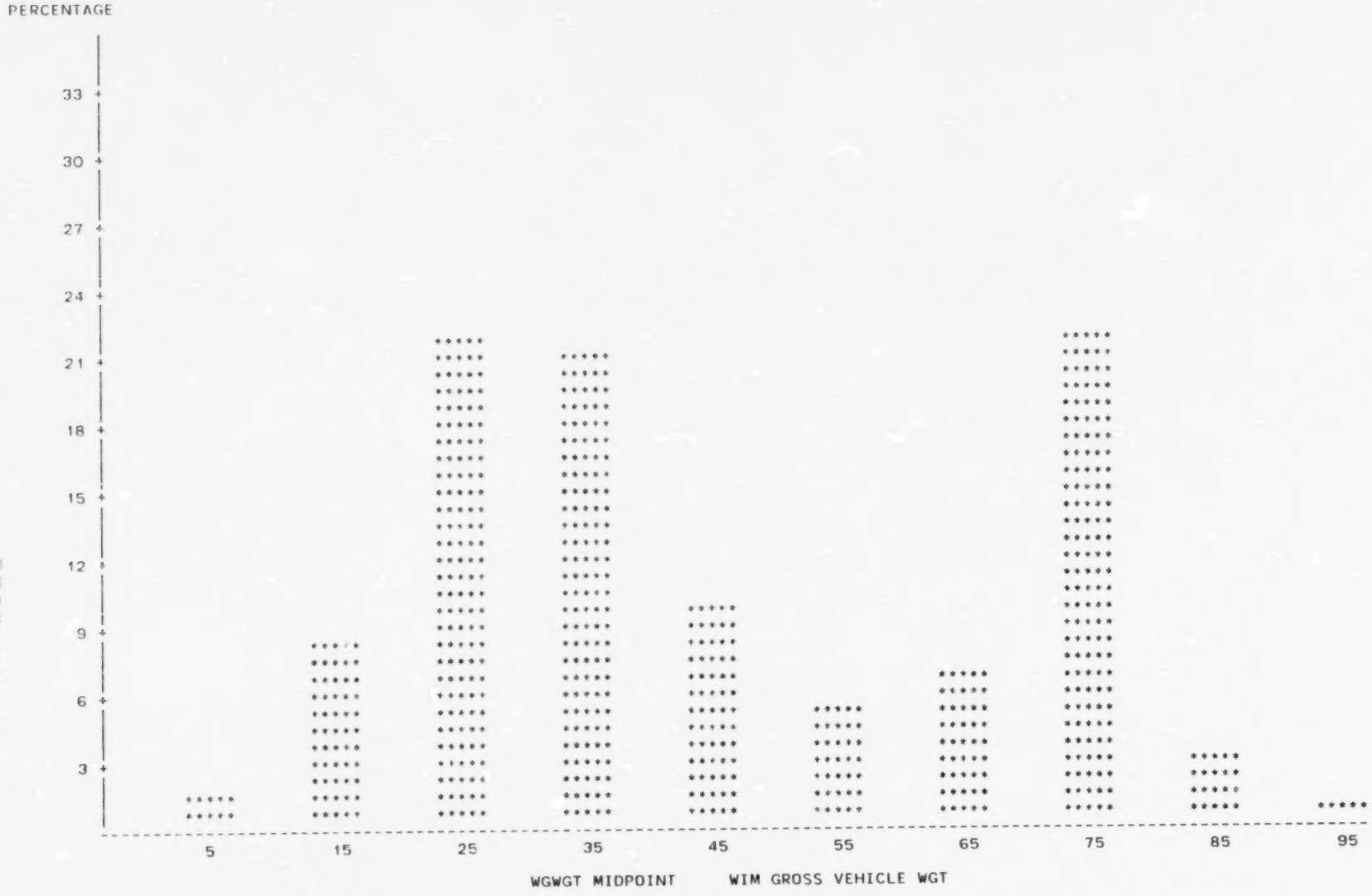
STATIC GROSS WEIGHTS ALL TRUCKS

PERCENTAGE BAR CHART



BRIDGE WIM GROSS WEIGHTS OF ALL TRUCKS

PERCENTAGE BAR CHART



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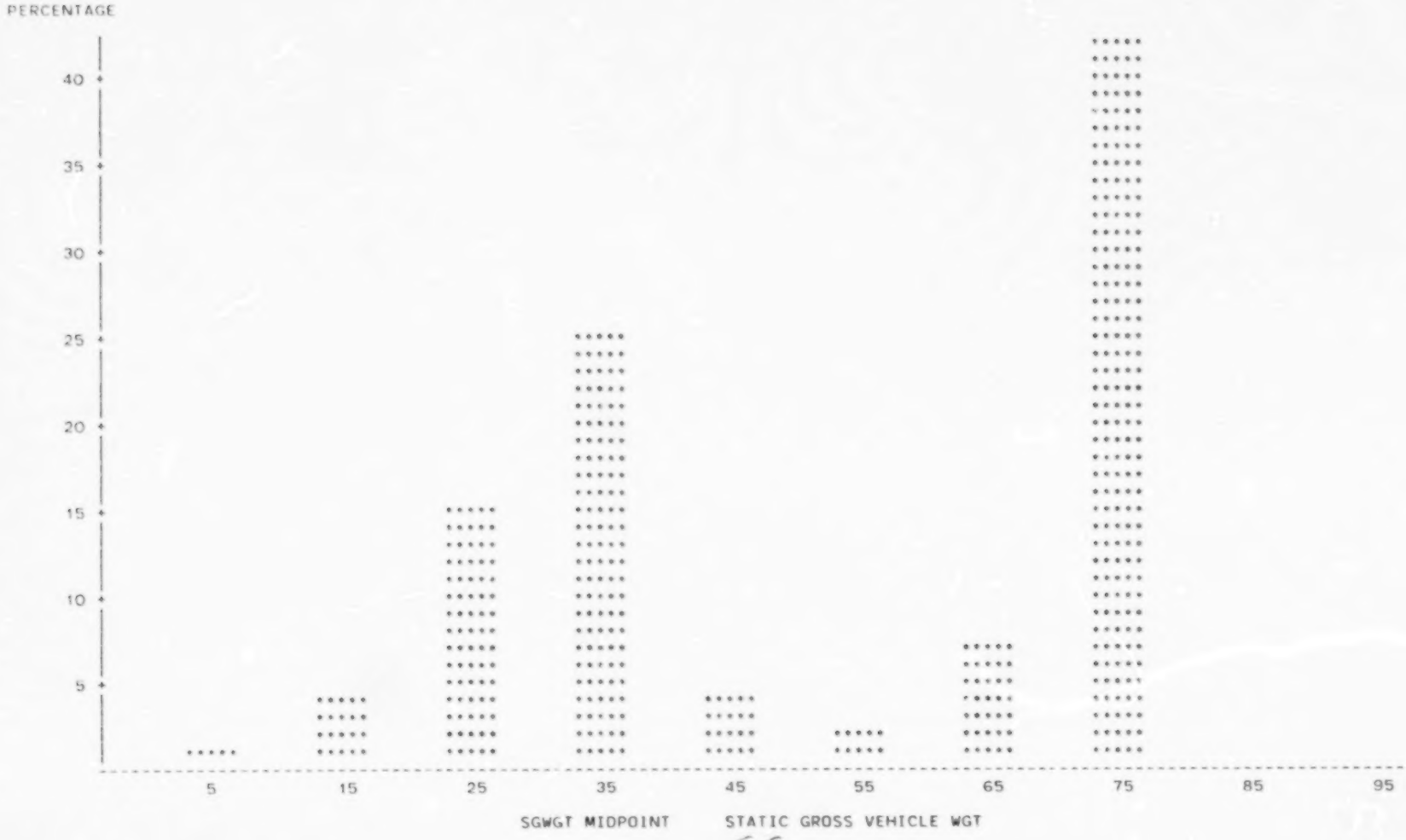
STATIC GROSS WEIGHTS ALL TRUCKS
BY SITE
SITE=LAX

PERCENTAGE BAR CHART



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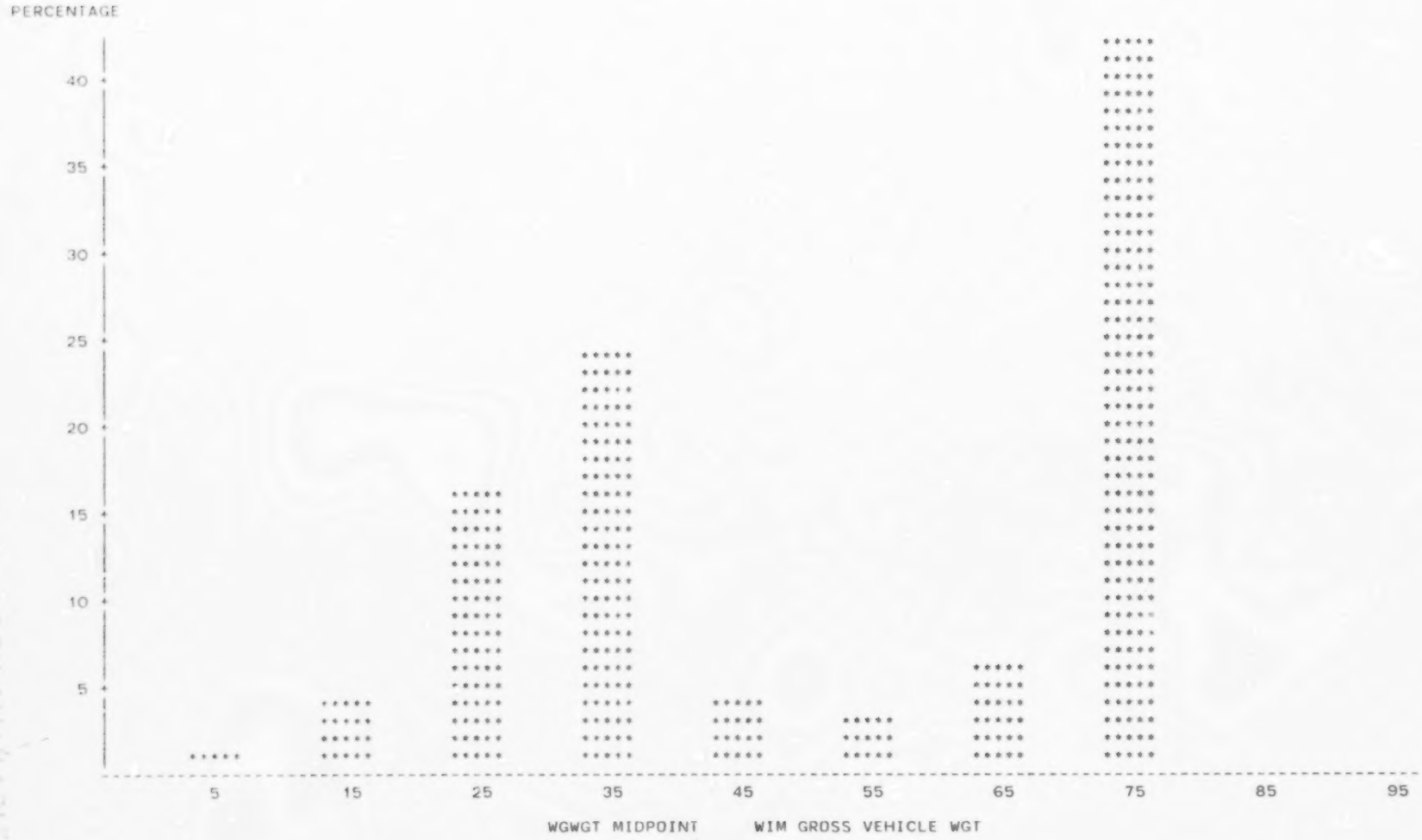
BRIDGE WIM GROSS WEIGHTS OF ALL TRUCKS
BY SITE
SITE=LAX

PERCENTAGE BAR CHART



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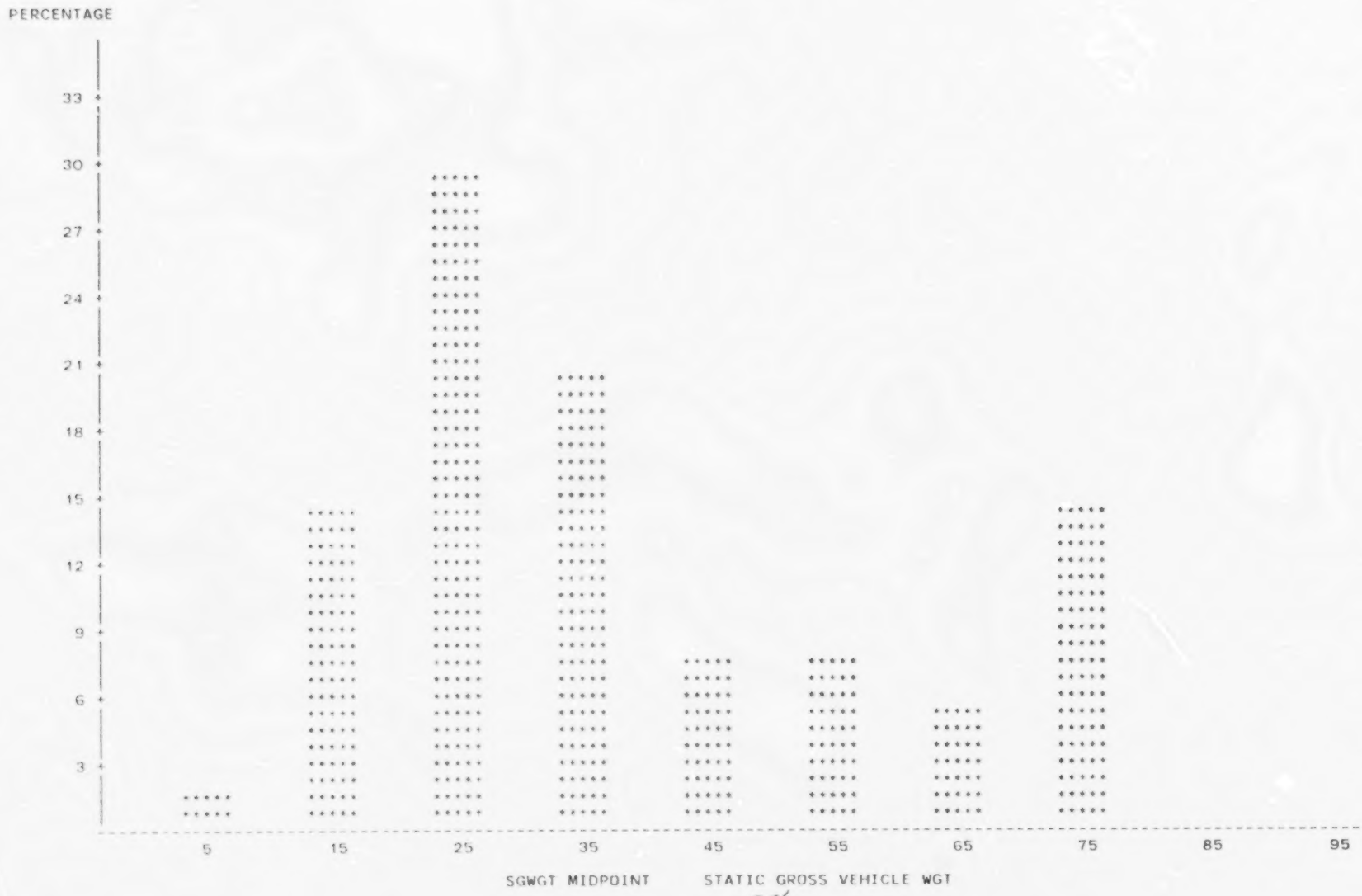
STATIC GROSS WEIGHTS ALL TRUCKS
BY SITE
SITE=STP

PERCENTAGE BAR CHART



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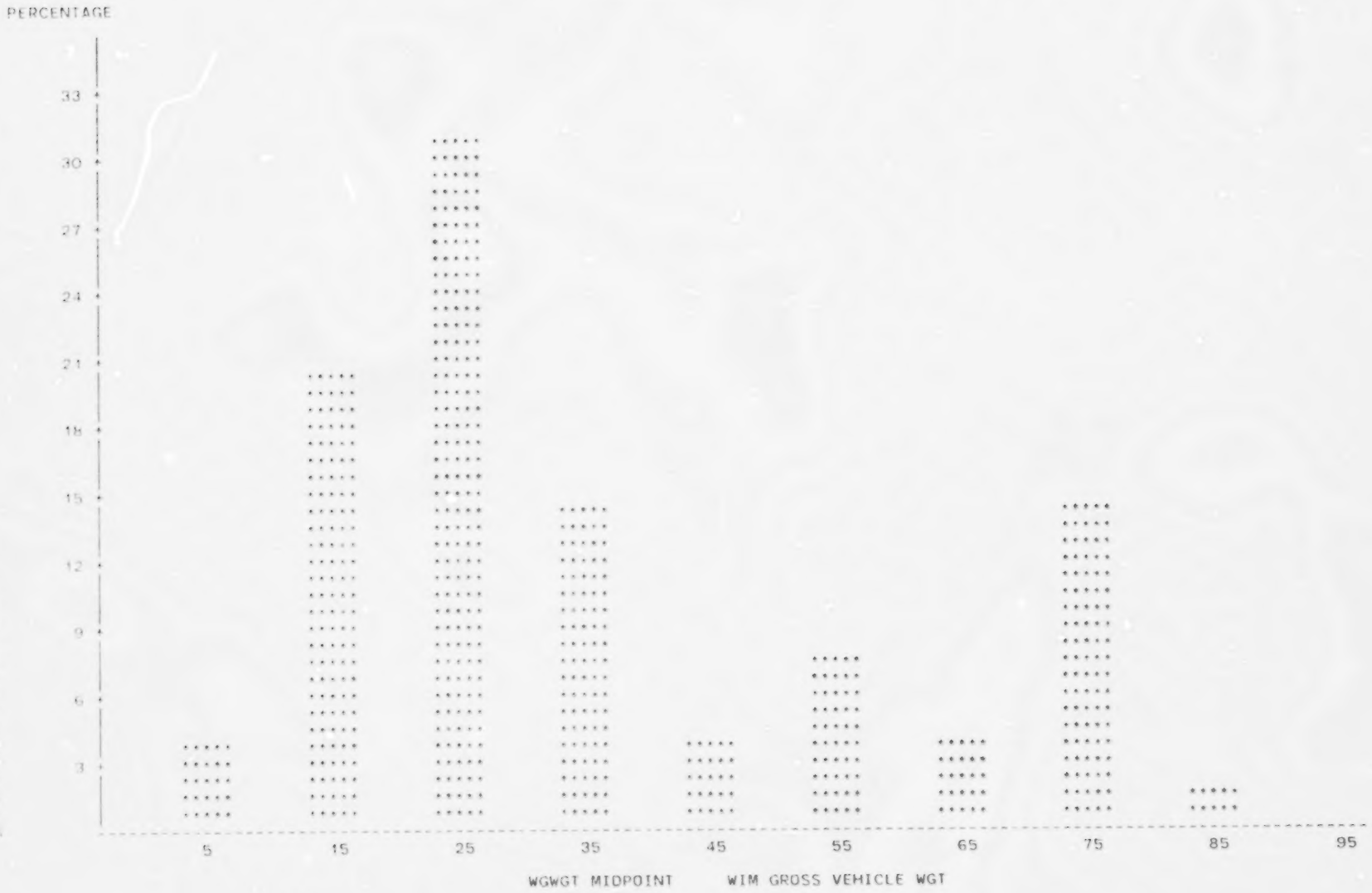
BRIDGE WIM GROSS WEIGHTS OF ALL TRUCKS
BY SITE
SITE=STP

PERCENTAGE BAR CHART



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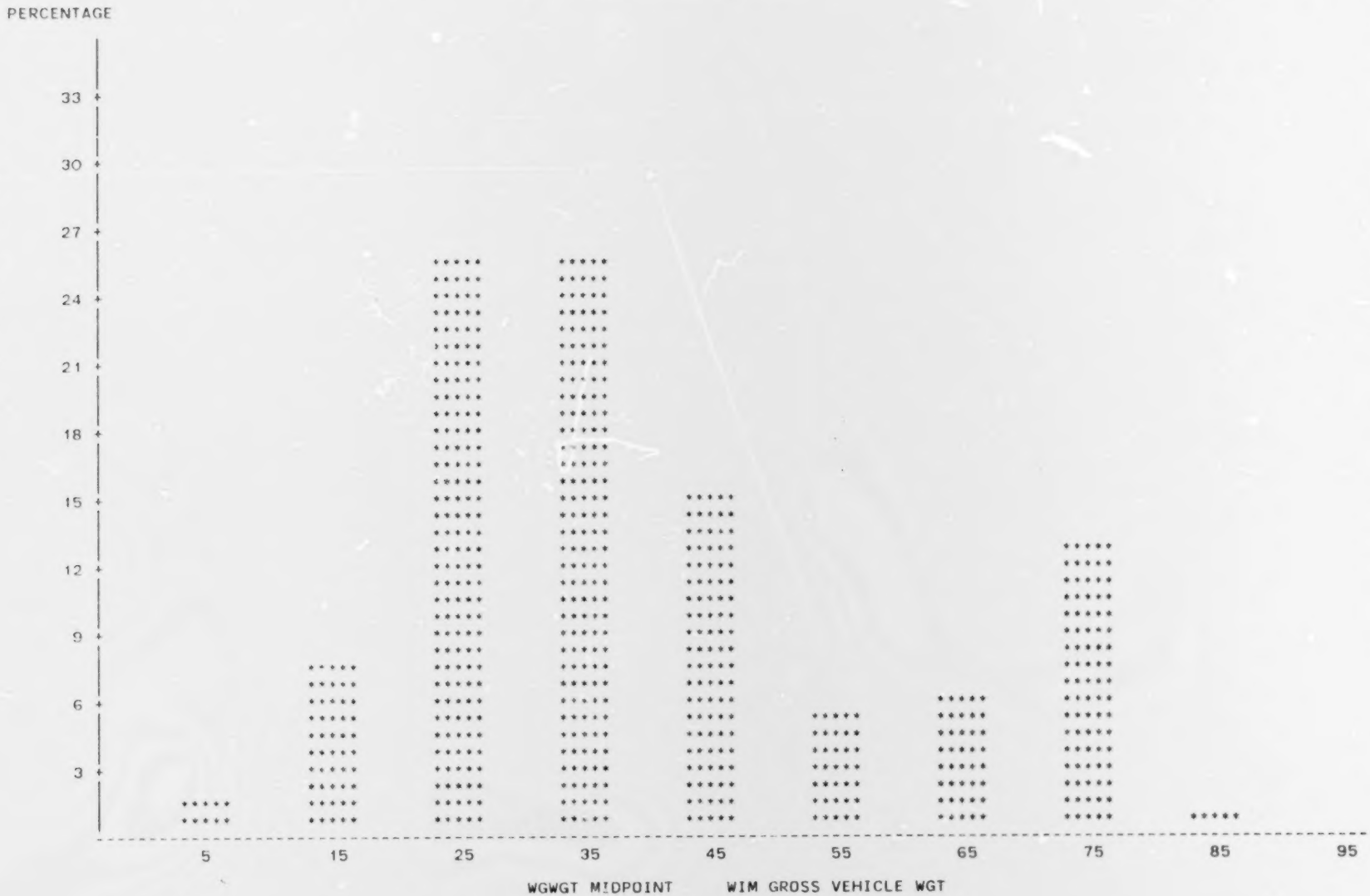
BRIDGE WIM GROSS WEIGHTS OF ALL TRUCKS
BY SITE
SITE=MNC

PERCENTAGE BAR CHART



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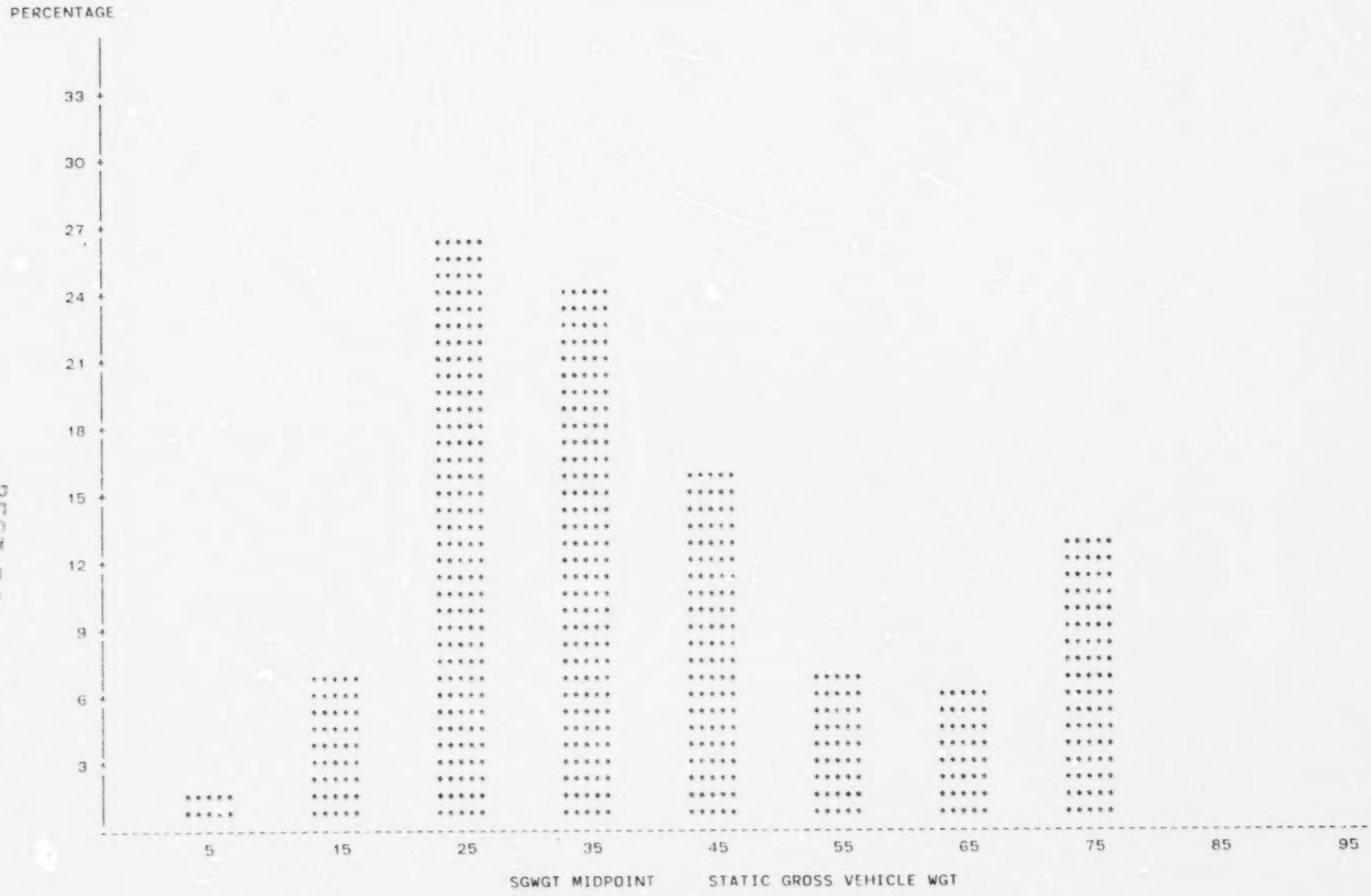
STATIC GROSS WEIGHTS ALL TRUCKS
BY SITE
SITE=MNC

PERCENTAGE BAR CHART



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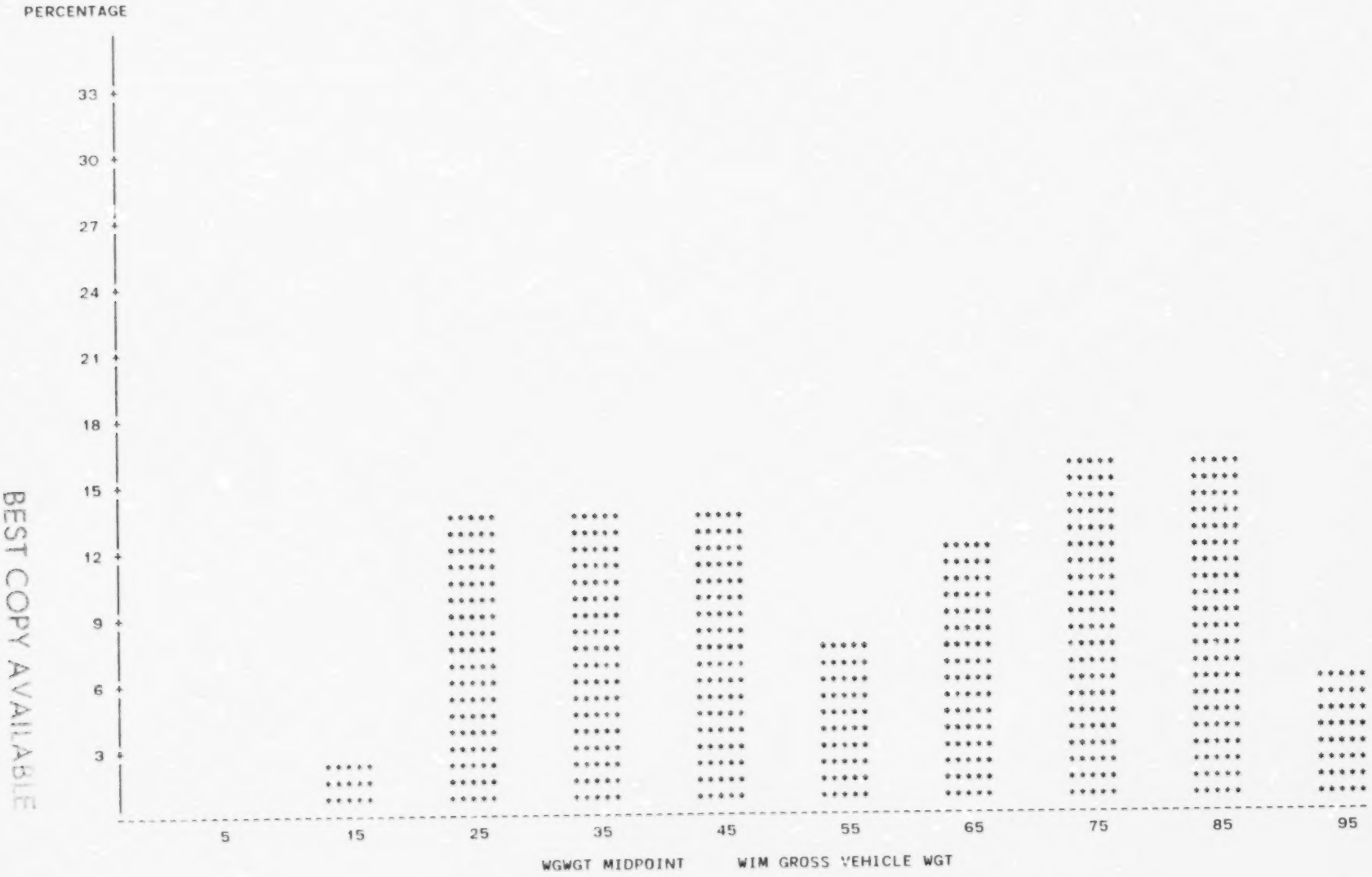
STATIC GROSS WEIGHTS ALL TRUCKS
BY SITE
SITE=UTC

PERCENTAGE BAR CHART

BEST COPY AVAILABLE

BRIDGE WIM GROSS WEIGHTS OF ALL TRUCKS
BY SITE
SITE=UTC

PERCENTAGE BAR CHART



BEST COPY AVAILABLE

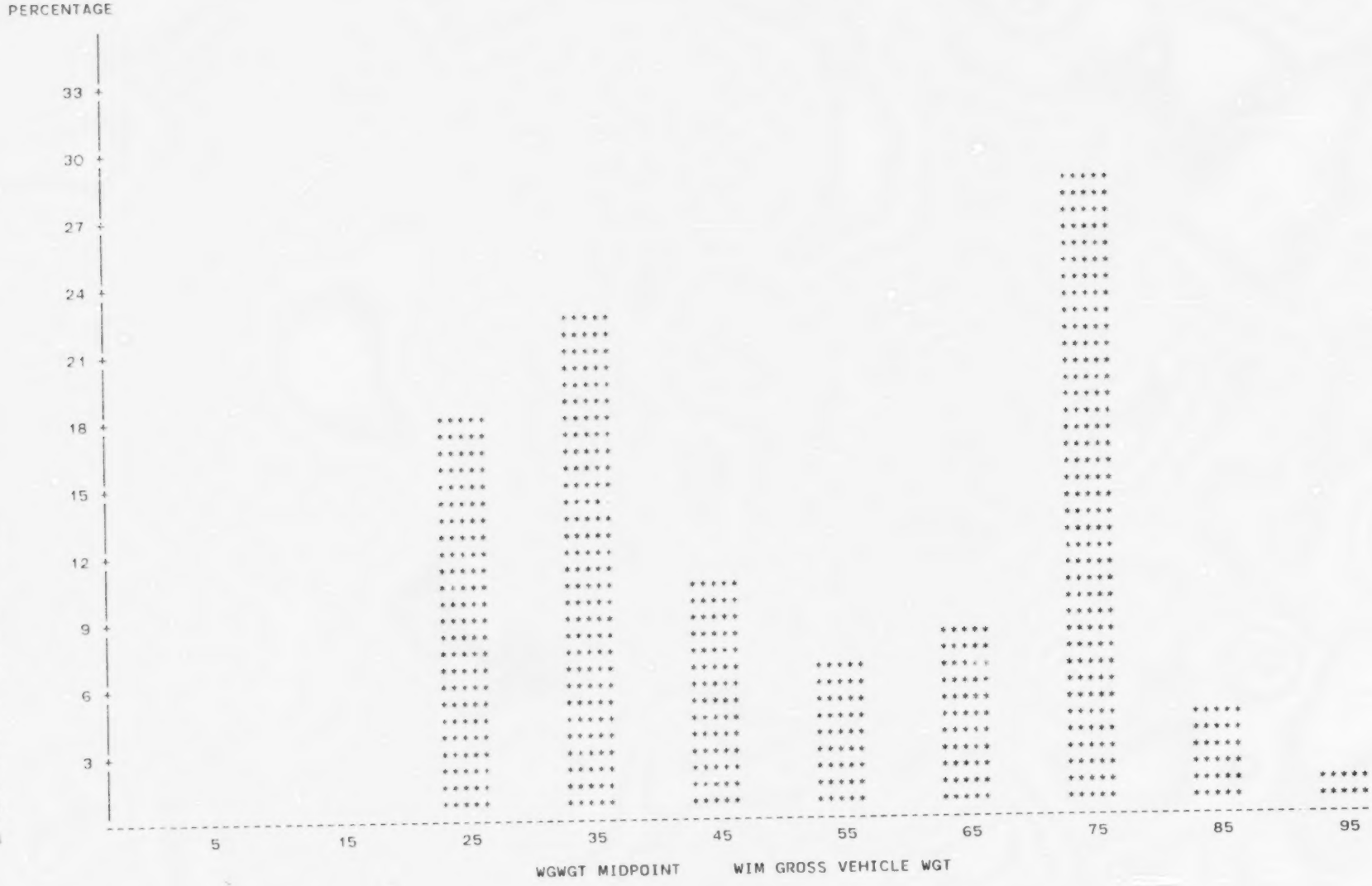
STATIC GROSS WEIGHTS OF 3S-2 TRUCKS
ALL SITES EXCEPT UTICA

PERCENTAGE BAR CHART

BEST COPY AVAILABLE

BRIDGE WIM GROSS WEIGHTS OF 3S-2 TRUCKS
ALL SITES EXCEPT UTICA

PERCENTAGE BAR CHART



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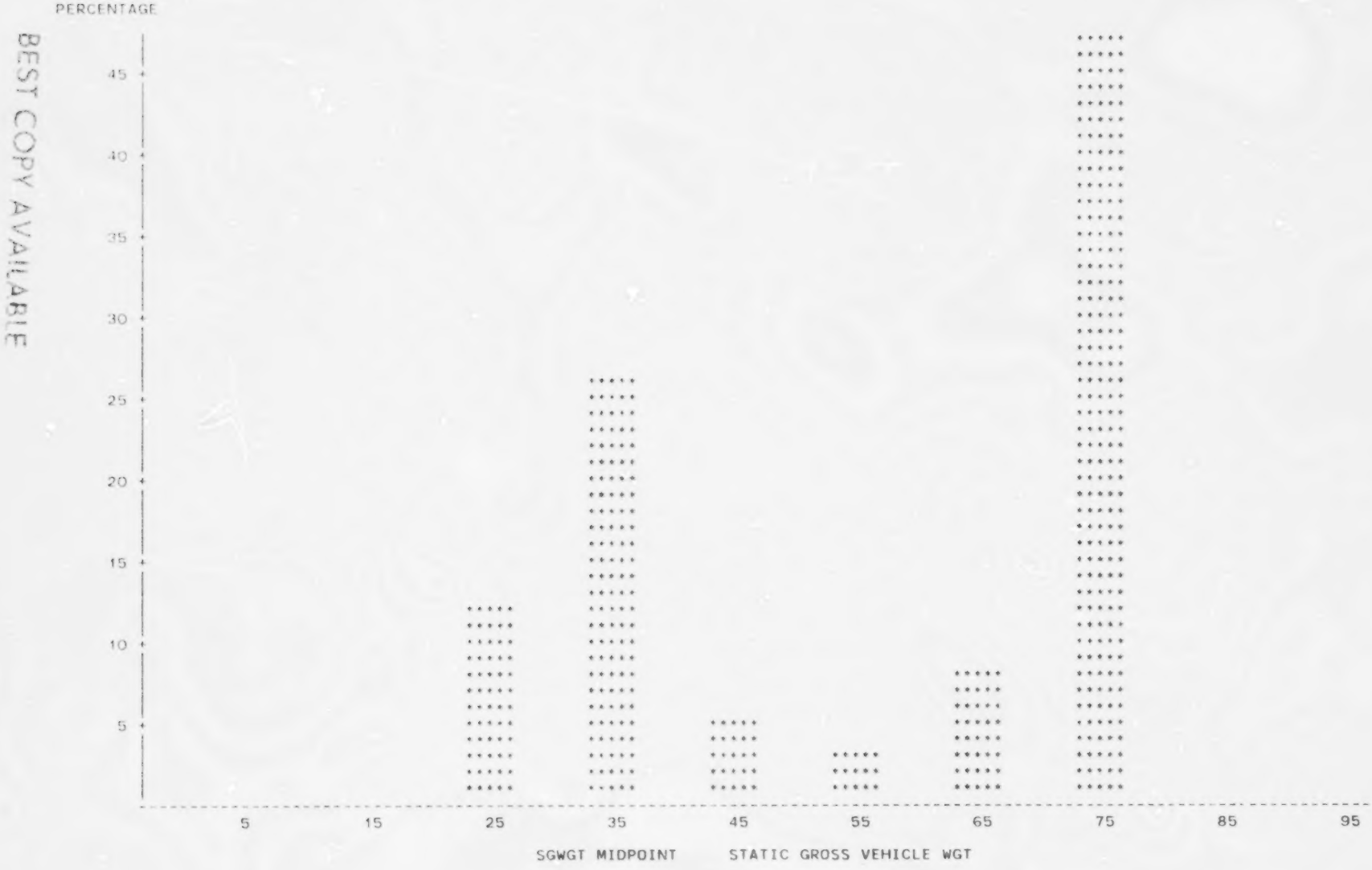
STATIC GROSS WEIGHTS OF 3S-2 TRUCKS
BY SITE
SITE=LAX

PERCENTAGE BAR. CHART



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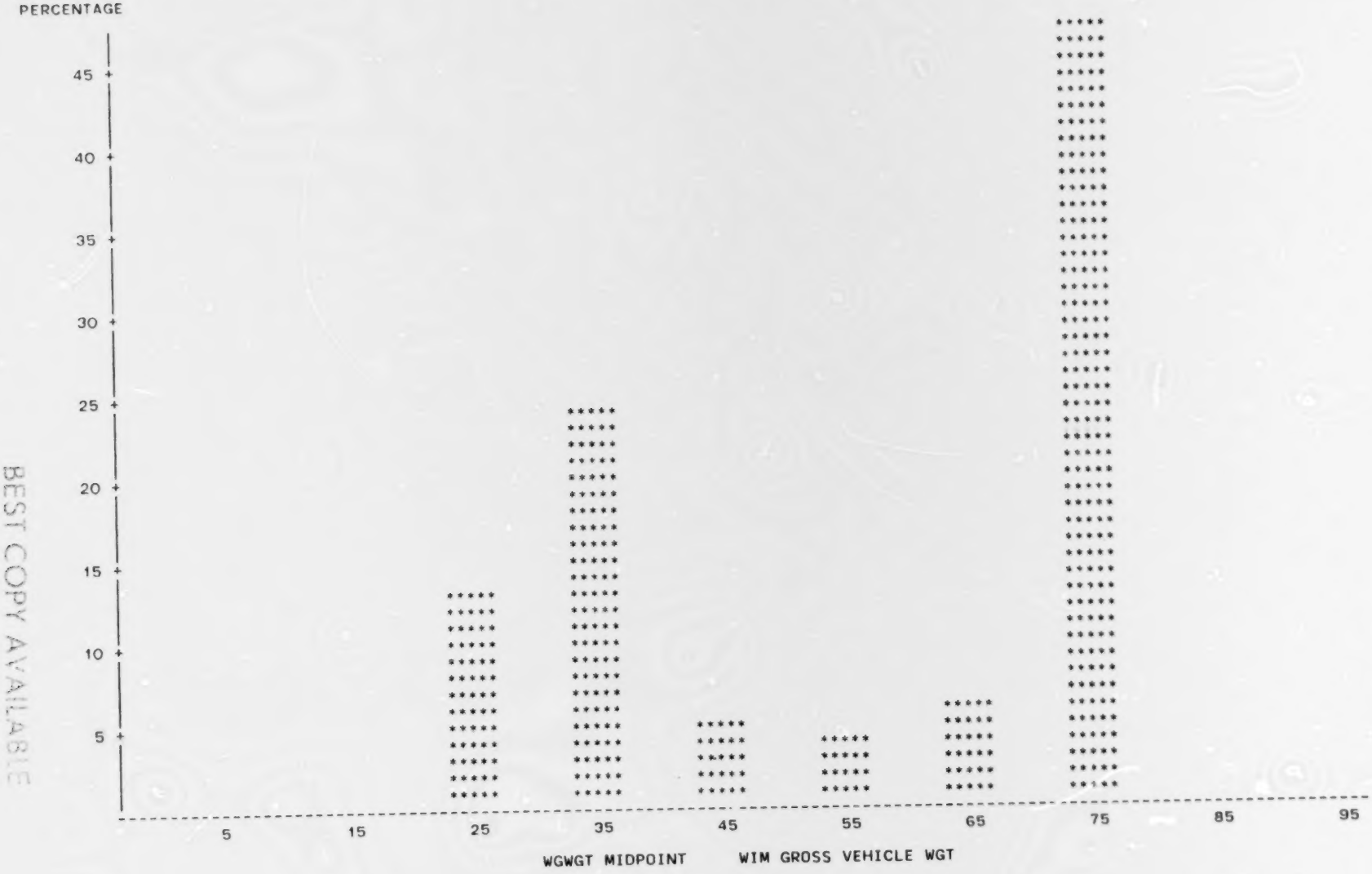
BRIDGE WIM GROSS WEIGHTS OF 3S-2 TRUCKS
BY SITE
SITE=LAX

PERCENTAGE BAR CHART



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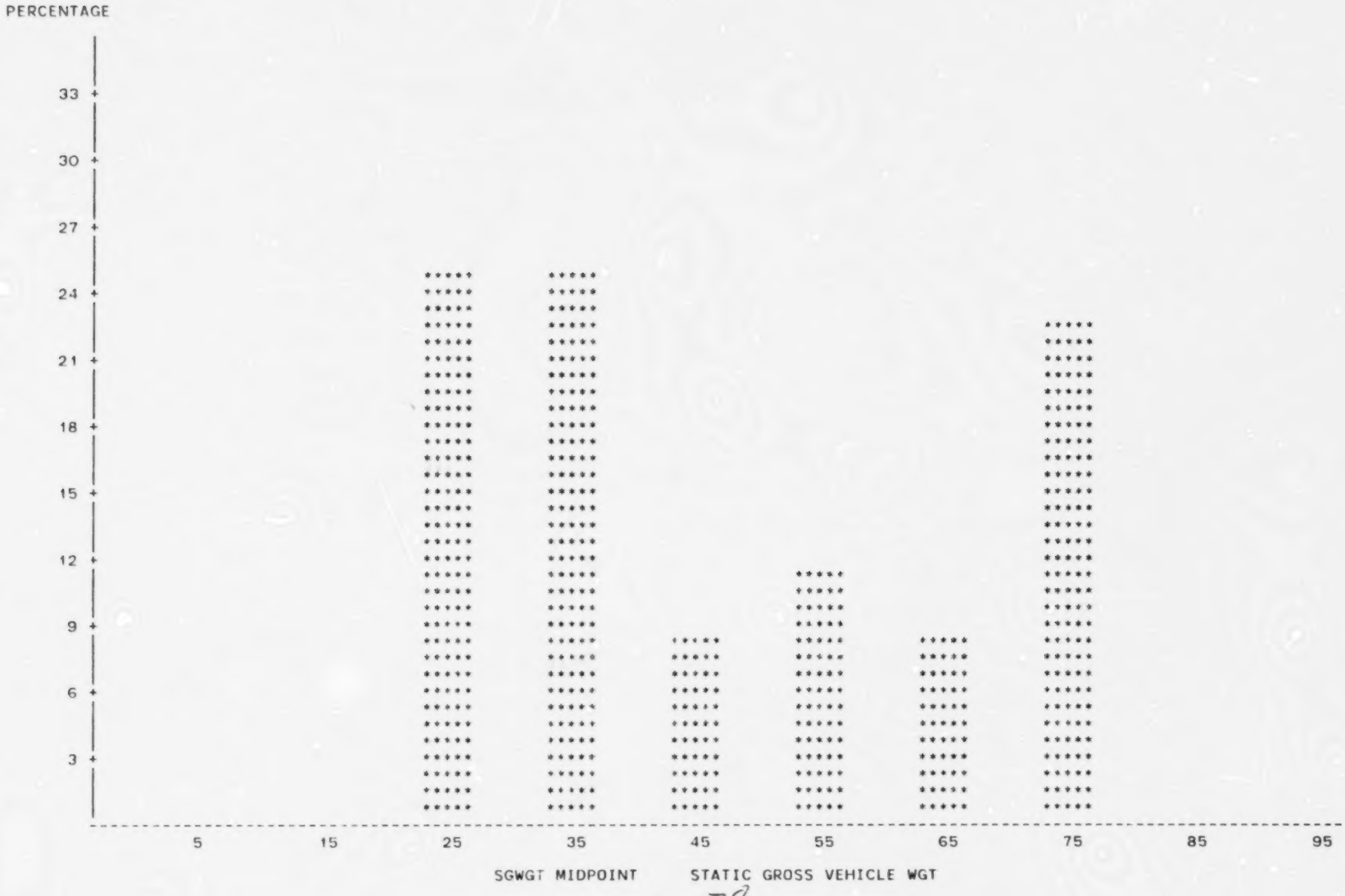
STATIC GROSS WEIGHTS OF 3S-2 TRUCKS
BY SITE
SITE=STP

PERCENTAGE BAR CHART



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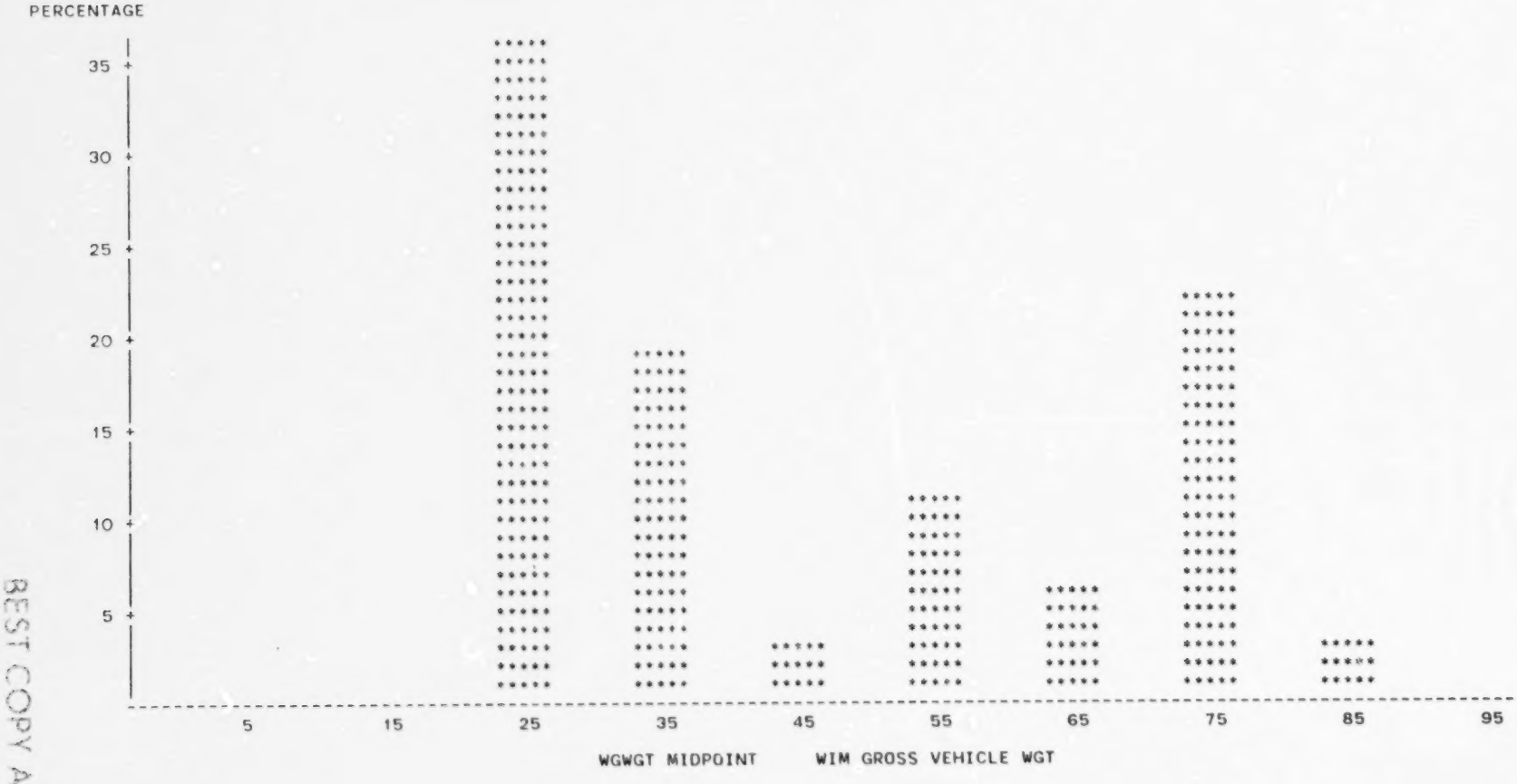
BRIDGE WIM GROSS WEIGHTS OF 3S-2 TRUCKS
BY SITE
SITE=STP

PERCENTAGE BAR CHART



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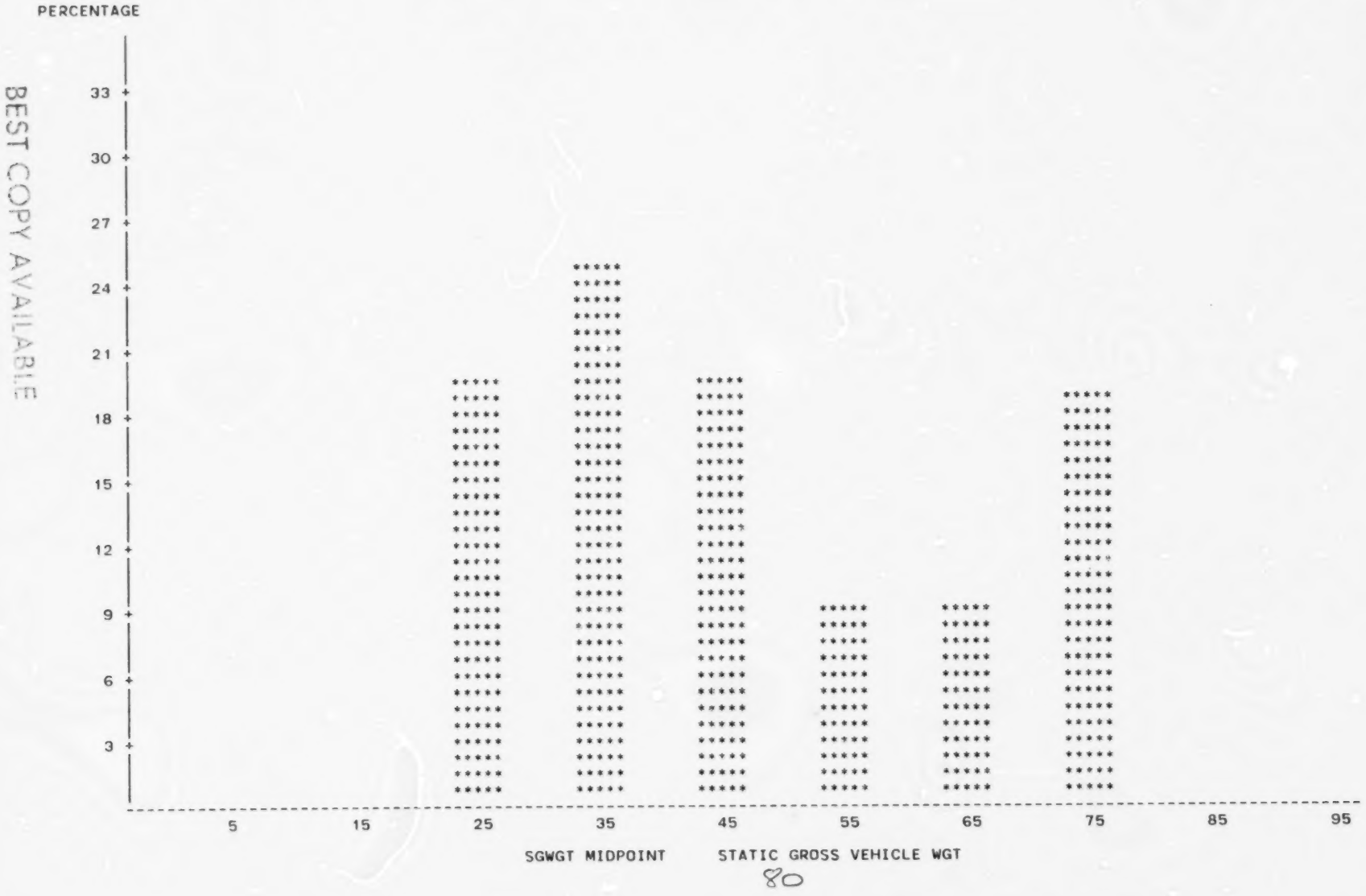
STATIC GROSS WEIGHTS OF 3S-2 TRUCKS
BY SITE
SITE=MNC

PERCENTAGE BAR CHART



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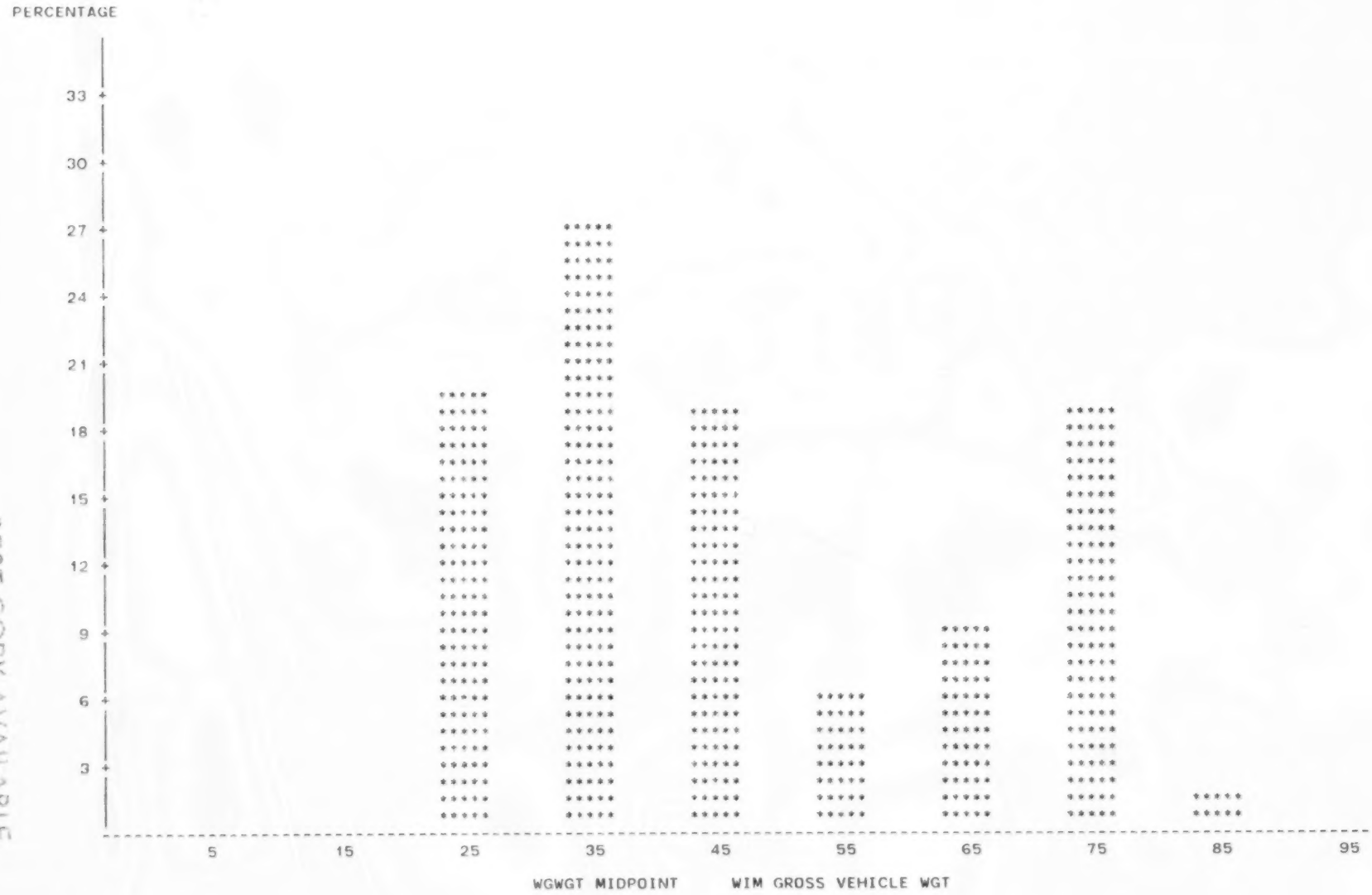
BRIDGE WIM GROSS WEIGHTS OF 3S-2 TRUCKS
BY SITE
SITE=MNC

PERCENTAGE BAR CHART



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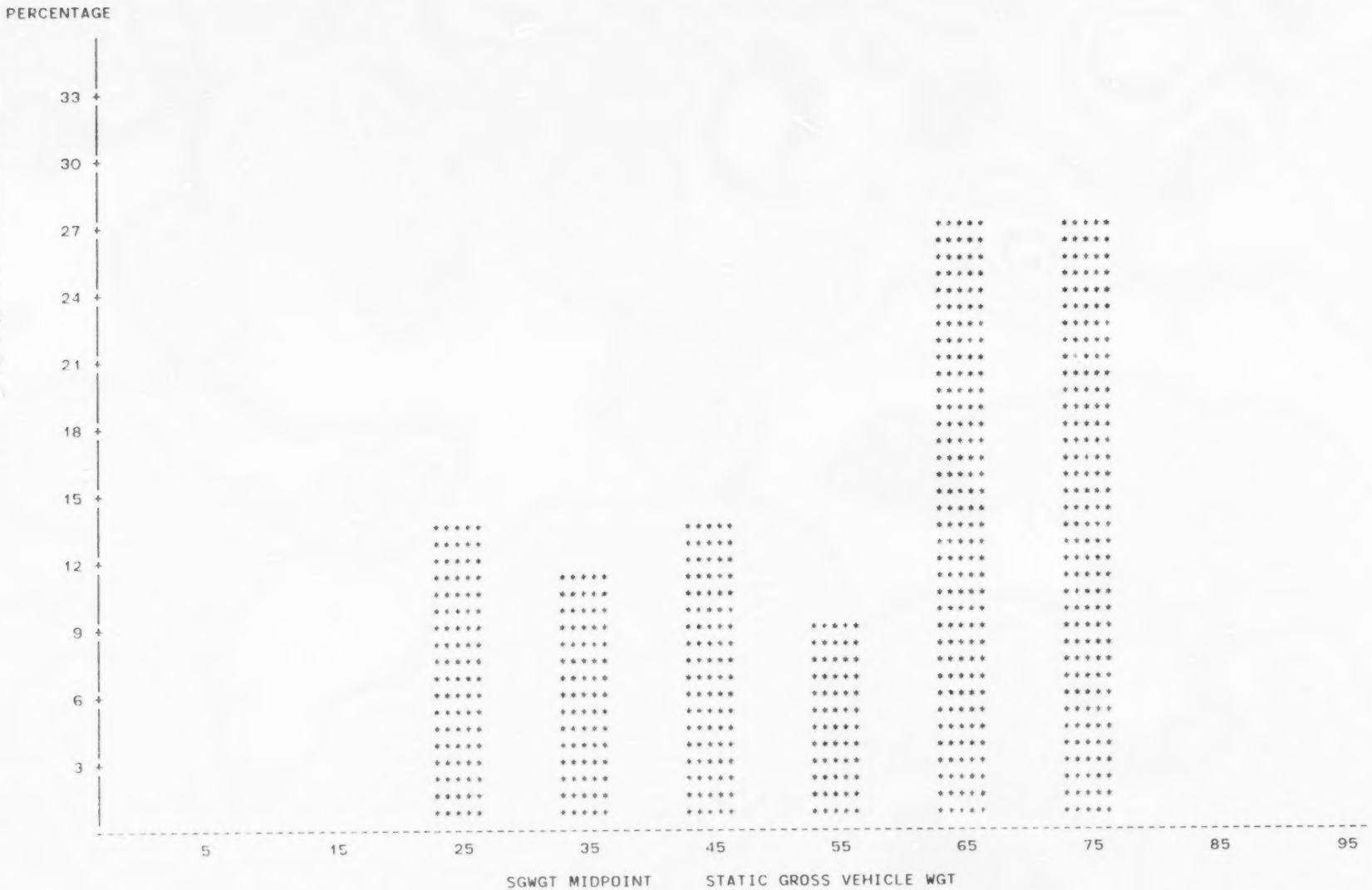
STATIC GROSS WEIGHTS OF 3S-2 TRUCKS
BY SITE
SITE=UTC

PERCENTAGE BAR CHART



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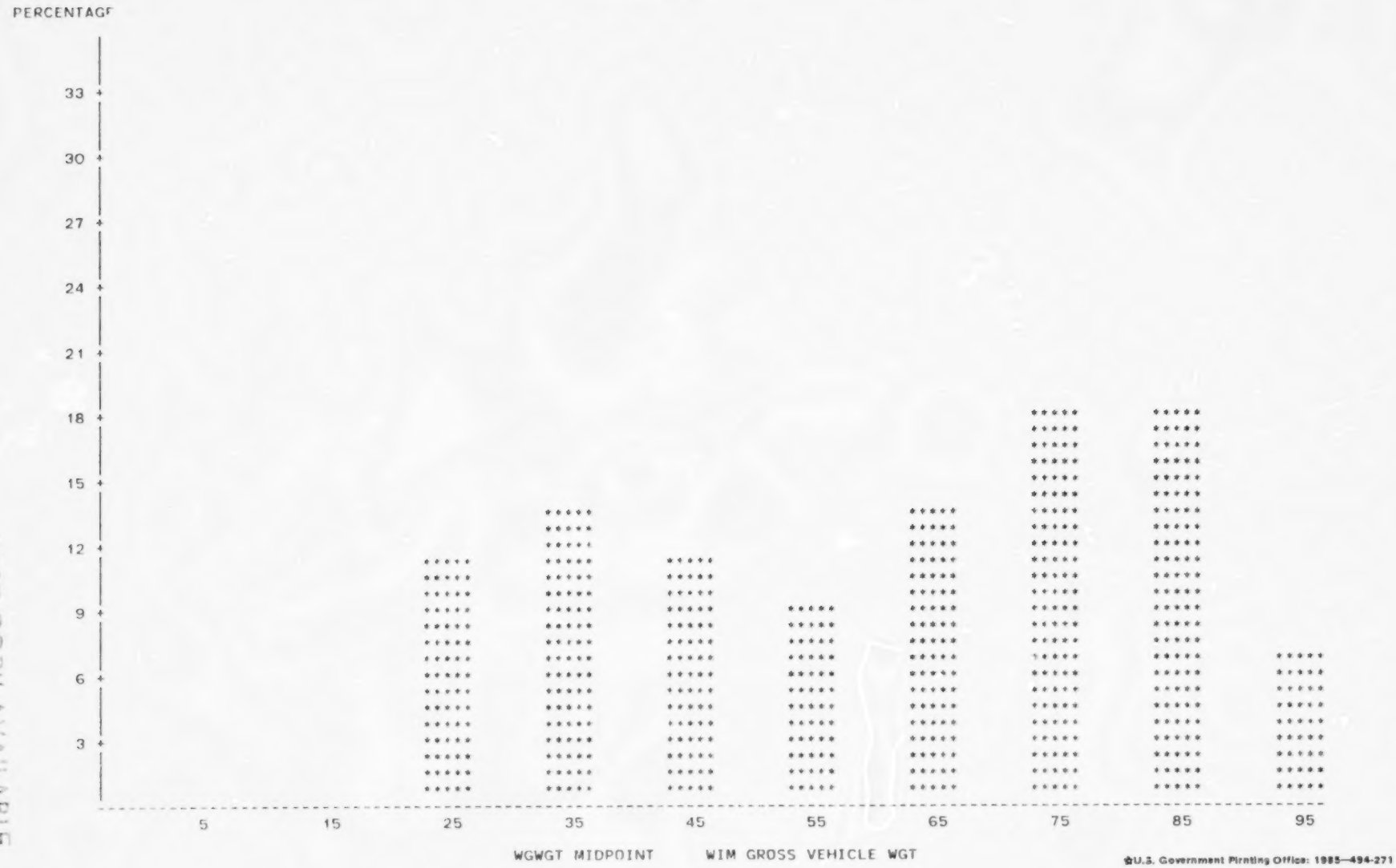
BRIDGE WIM GROSS WEIGHTS OF 3S-2 TRUCKS
BY SITE
SITE=UTC

PERCENTAGE BAR CHART



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